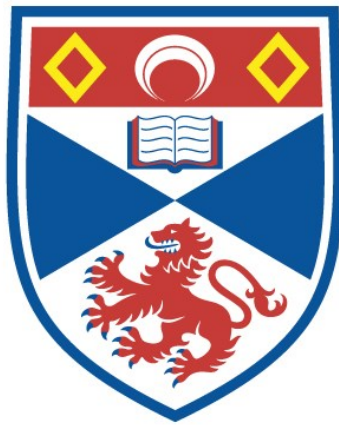


**PROCESSING OF EMOTIONAL MATERIAL IN MAJOR
DEPRESSION : COGNITIVE AND NEUROPSYCHOLOGICAL
INVESTIGATIONS**

Nathan Ridout

**A Thesis Submitted for the Degree of PhD
at the
University of St Andrews**



2005

**Full metadata for this item is available in
St Andrews Research Repository
at:**

<http://research-repository.st-andrews.ac.uk/>

Please use this identifier to cite or link to this item:

<http://hdl.handle.net/10023/13141>

This item is protected by original copyright

**Processing of emotional material in
major depression: Cognitive and
neuropsychological investigations**

Nathan Ridout

Submitted for the degree of Doctor of Philosophy

University of St. Andrews

September 2004



ProQuest Number: 10166875

All rights reserved

INFORMATION TO ALL USERS

The quality of this reproduction is dependent upon the quality of the copy submitted.

In the unlikely event that the author did not send a complete manuscript and there are missing pages, these will be noted. Also, if material had to be removed, a note will indicate the deletion.



ProQuest 10166875

Published by ProQuest LLC (2017). Copyright of the Dissertation is held by the Author.

All rights reserved.

This work is protected against unauthorized copying under Title 17, United States Code
Microform Edition © ProQuest LLC.

ProQuest LLC.
789 East Eisenhower Parkway
P.O. Box 1346
Ann Arbor, MI 48106 – 1346

Th
E 914

(i). I, Nathan Ridout certify that this thesis submission, which is approximately 69,000 words in length, has been written by me, that it is a record of work carried out by me, and that it has not been submitted previously in any application for a higher degree.

Date 4th May 2005 Signature _____

Printed name _____

(ii) I was admitted as a postgraduate research student into the School of Psychology, University of St Andrews, in September 2000. I was subsequently admitted into the same academic department as a candidate for the degree of Ph.D. in September 2001. The higher study for which this thesis is a record was carried out between 2000 and 2004 at the University of St Andrews and in the Affective Disorders Clinic at Ninewells Hospital, in Dundee.

Date 4th May 2005 Signature _____

Printed name _____

(iii) I hereby certify that the candidate has fulfilled the conditions of the resolution and regulations appropriate for the degree of Ph.D. in the University of St. Andrews and that the candidate is qualified to submit this thesis in application for that degree

Date 4/5/05 Signature of supervisor _____

Printed name _____

In submitting this thesis to the University of St. Andrews I understand that I am giving permission for it to be made available for use in accordance with the regulations of the University Library for the time being in force, subject to copyright vested in the work not being affected thereby. I also understand that the title and abstract will be published, and that a copy of the work may be made and supplied to any *bona fide* library or research worker.

Date 04/05/2005 Signature of candidate _____

Printed name _____

ABSTRACT

The aim of this thesis was to expand the existing knowledge base concerning the profile of emotional processing that is associated with major depression, particularly in terms of socially important non-verbal stimuli (e.g. emotional facial expressions). **Experiment one** utilised a face-word variant of the emotional Stroop task and demonstrated that depressed patients (DP) did not exhibit a selective attention bias for sad faces. Conversely, the healthy controls (HC) were shown to selectively attend to happy faces. At recognition memory testing, DP did not exhibit a memory bias for depression-relevant words, but did demonstrate a tendency to falsely recognise depression-relevant words that had not been presented at encoding. **Experiment two** examined the pattern of autobiographical memory (ABM) retrieval exhibited by DP and HC in response to verbal (words) and non-verbal (images & faces) affective cues. DP were slower than HC to retrieve positive ABMs, but did not differ from HC in their retrieval times for negative ABMs. Overall, DP retrieved fewer specific ABMs than did the HC. Participants retrieved more specific ABMs to image cues than to words or faces, but this pattern was only demonstrated by the HC. Reduced retrieval of specific ABMs by DP was a consequence of increased retrieval of categorical ABMs; this tendency was particularly marked when the participants were cued with faces. During **experiment three**, DP and HC were presented with a series of faces and were asked to identify the gender of the person featured in each photograph. Overall, gender identification times were not affected by the emotion portrayed by the faces. Furthermore at subsequent recognition memory testing, DP did not exhibit MCM bias for sad faces. During **experiment four**, DP and HC were presented with videotaped depictions of 'realistic' social interactions and were asked to identify the emotion portrayed by the characters and to make inferences about the thoughts, intentions and beliefs of these individuals. Overall, DP were impaired in their recognition of happiness and in understanding social interactions involving sarcasm and deception. Correct social inference was significantly related to both executive function and depression severity. **Experiment five** involved assessing a group of eight patients that had undergone

neurosurgery for chronic, treatment-refractory depression on the identical emotion recognition and social perception tasks that were utilised in experiment four. Relative to HC, surgery patients (SP) exhibited general deficits on all emotion recognition and social processing tasks. Notably, depression status did not appear to interact with surgery status to worsen these observed deficits. These findings suggest that the anterior cingulate region of the prefrontal cortex may play a role in correct social inference. **Summary:** Taken together the findings of the five experimental studies of the thesis demonstrate that, in general, biases that have been observed in DP processing of affective verbal material generalise to non-verbal emotional material (e.g. emotional faces). However, there are a number of marked differences that have been highlighted throughout the thesis. There is also evidence that biased emotional processing in DP requires explicit processing of the emotional content of the stimuli. Furthermore, a central theme of the thesis is that deficits in executive function in DP appear to be implicated in the impairments of emotional processing that are exhibited by these patients.

ACKNOWLEDGEMENTS

First, I would especially like to thank Professor Ronan O' Carroll and Dr Barbara Dritschel for their excellent supervision. They have fuelled my enthusiasm for my subject, whilst endeavouring to keep my feet on the ground. I am grateful to Ronan for his advice, encouragement, and great sense of humour. Having been supervised by Ronan during my Masters, I was especially glad that I was able to continue this excellent working relationship. I would also like to thank Barbara for all her efforts during the past four years, particularly during the last year. She has provided excellent advice, support and encouragement, and has helped to keep me sane during the final stages of writing this thesis!

I would like to thank everyone at the Affective Disorders Clinic (ADC) at Ninewells Hospital, Dundee. In particular, I am extremely grateful to Professor Keith Matthews for his efforts in finding willing patients for my experiments, for his advice on the research and for his humour. I would also like to thank Professor Ian Reid for his help and advice during the initial stages of my research. Furthermore, I would like to express my gratitude to the psychiatrists at the ADC for their invaluable help in recruiting the patients. I am particularly grateful to Dr Richard Day, Dr David Christmas, Dr Colin Morrison, Dr Steve Curran and Dr Maureen McVicar. Finally, I would like to thank the secretaries, in particular Francis, for their efforts during my research.

I am extremely grateful to the individuals (patients & controls) who agreed to take part in my studies, as I would not have been able to do my research without them. I am especially grateful to the patients for participating at such a difficult time in their lives.

I would especially like to thank my parents, my family, and my friends for their love and support during the last four years. Finally, I am eternally grateful to Debbie for her advice, encouragement and patience, and her constant love and support.

CONTENTS

Abstract	I
Acknowledgements	III
Contents	IV
Tables	XVI
Figures	XVIII
Published work from this thesis	XXI
Overview of the experimental chapters of the thesis	XXII

CHAPTER ONE: GENERAL INTRODUCTION

1.1 Background	1
1.2 General cognitive impairment in MD	3
1.2.1 Cognitive and psychomotor retardation in MD	4
1.2.2 Memory function in MD	5
1.2.3 Attention and concentration in MD	7
1.2.4 'Executive' function in MD	10
1.3. Possible factors influencing cognitive impairment in MD	11
1.3.1. Depression severity	11
1.3.2. Task demands	12
1.3.3. Processing resources	13
1.3.4. Motivation	14
1.3.5. Rumination	15
1.3.6. Other potential influences on cognitive impairment in <i>MD</i>	16
1.4. Processing of emotional material in MD	16

1.4.1. Memory for emotional material in MD	16
1.4.1.1. <i>Autobiographical memory (ABM) in MD</i>	17
1.4.1.2. <i>Mood-congruent memory (MCM) bias for experimental materials in MD</i>	23
1.4.2. Selective attention for affective material in MD	28
1.4.3. Emotion recognition and social judgement in MD	32
1.5. Cognitive theories of MD	36
1.5.1. Beck's Schema theory and Bower's network theory	36
1.5.2. Williams, Watts, MacLeod & Mathews	37
1.5.3. Teasdale and Barnard's ICS model	40
1.6. Neural changes underlying mood and cognitive deficits in MD	41
1.7. Summary and Research Overview	43

CHAPTER TWO: COMMON MEASURES AND METHODOLOGIES

2.1. Introduction	46
2.2. Diagnosis of Major Depression	46
2.3. Clinical Assessment of Depression Severity	47
2.3.1. The Hamilton Rating Scale for Depression (HRSD)	47
2.4. Self-report Measures of Mood	50
2.4.1. The Beck Depression Inventory (BDI)	50
2.4.2. The Hospital Anxiety and Depression Scale (HADS)	52
2.5. Estimation of Pre-morbid Intellectual Ability	53
2.6. General Assessment of Patients and Controls	54

2.6.1. General Assessment of Patients	54
2.6.2. General Assessment of Healthy Participants	54
2.6.3. Inclusion and exclusion criteria for the clinical studies	55
2.7. Data Analysis	56
2.8. Summary and Conclusions	56

CHAPTER THREE: SELECTIVE ATTENTION AND RECOGNITION MEMORY FOR AFFECTIVE WORDS IN MAJOR DEPRESSION: *THE INFLUENCE OF DISTRACTING EMOTIONAL FACIAL EXPRESSION*

3.1. Introduction	58
3.1.1. Selective attention for emotional faces in major depression	60
3.1.2. Recognition memory for affective material in major depression	62
3.1.3. Investigating false memories in major depression	64
3.1.4. Overview and Predictions	64
3.1.4.1. <i>Hypotheses tested during the selective attention phase</i>	65
3.1.4.2. <i>Hypotheses tested during the recognition memory phase</i>	66
3.2. Method	66
3.2.1. Design	66
3.2.2. Participants	67
3.2.3. Materials and Apparatus	68
3.2.3.1. <i>Emotional Facial Expressions (distracters)</i>	68

3.2.3.2. <i>Affective Words</i>	69
3.2.3.3. <i>Compound Stimuli</i>	70
3.2.3.4. <i>Assessment of Psychomotor Speed</i>	72
3.2.3.5. <i>Stimulus Presentation</i>	72
3.2.4. Procedure	73
3.2.4.1. <i>Selective attention task</i>	73
3.2.4.2. <i>Recognition memory task</i>	74
3.2.4.3. <i>Data Analysis</i>	74
3.3. Results and Discussion (Selective Attention Task)	75
3.3.1. Participant characteristics	75
3.3.2. Valence Identification Times	77
3.3.3. Percentage of Valence Identification Errors	86
3.3.4. Is the face-word task strictly a test of selective attention?	88
3.3.5. Summary and Conclusions (Selective Attention Task)	90
3.4. Results and Discussion (Recognition Memory Task)	91
3.4.1. Percentage of correct recognitions	91
3.4.2. Signal Detection Analysis	94
3.4.3. False recognition of non-presented “lure” words	95
3.4.4. Summary and Conclusions (Recognition Memory Phase)	97
3.5. General Discussion	97
3.5.1. The influence of emotional facial expressions on processing of concurrently presented affective words	97
3.5.2. Methodological Considerations	99
3.5.3. Summary and Conclusions	100

CHAPTER FOUR: AUTOBIOGRAPHICAL MEMORY IN MAJOR DEPRESSION: DIFFERENT RESPONSES TO VERBAL AND VISUAL EMOTIONAL CUES?

4.1. Introduction	102
4.1.1. Depression and Autobiographical Memory	102
4.1.2. Cueing Autobiographical Memories	103
4.1.3. The Visually Cued ABM Test	106
4.1.4. Major Depression and the Visually Cued ABM Test	107
4.1.5. Overview and Predictions	109
4.2. Method	110
4.2.1. Design	110
4.2.2. Participants	111
4.2.3. Materials and Apparatus	112
4.2.3.1. <i>Emotional Words</i>	112
4.2.3.2. <i>Emotional Images</i>	112
4.2.3.3. <i>Emotional Facial Expressions</i>	113
4.2.3.4. <i>Stimulus Presentation</i>	114
4.2.3.5. <i>Response Measurement</i>	114
4.2.3.6. <i>Pleasantness Rating</i>	114
4.2.4. Procedure	115
4.2.5. Coding of retrieved ABMs	116
4.2.6. Data Analysis	116
4.3 Results	118
4.3.1. Participant Characteristics	118
4.3.2. ABM Retrieval Times	119

4.3.3. Specificity of retrieved ABMs	123
4.3.4. Type of Retrieval Errors	126
Discussion	133
4.4. 4.4.1. ABM Retrieval Times	134
4.4.2. Specificity of ABM retrieval	135
4.4.3. Type of Retrieval Errors	138
4.4.4. Summary and Conclusions	140

CHAPTER FIVE: MEMORY BIAS FOR EMOTIONAL FACIAL EXPRESSIONS IN MAJOR DEPRESSION: DOES IT REQUIRE DIRECT PROCESSING OF VALENCE AT ENCODING?

5.1. Introduction	143
5.1.1. Mood-congruent memory bias in major depression	143
5.1.2. Overview and Predictions	146
<i>5.1.2.1. Hypothesis tested during the gender decision phase</i>	146
<i>5.1.2.2. Hypothesis tested during the recognition memory phase</i>	147
5.2. Method	147
5.2.1. Design	147
5.2.2. Participants	147
5.2.3. Materials and Apparatus	148
<i>5.2.3.1. Emotional facial expressions</i>	148
<i>5.2.3.2. Simple reaction time task</i>	150
<i>5.2.3.3. Stimulus presentation</i>	151

5.2.3.4. <i>Measurement of self-rated mood</i>	151
5.2.3.5. <i>Assessment of pre-morbid intellectual ability</i>	151
5.2.3.6. <i>Other tasks (distracter tasks)</i>	152
5.2.4. Procedure	152
5.2.4.1. <i>Gender identification Task</i>	152
5.2.4.2. <i>Recognition Memory Test for Emotional Faces</i>	152
5.2.5. Data Analysis	153
5.3. Results	153
5.3.1. Participant Characteristics	153
5.3.2. Digit Symbol and Digit Span Tasks	155
5.3.3. Simple Reaction Time	155
5.3.4. Gender Identification Time	155
5.3.5. Percentage of Correct Recognitions	156
5.4. Discussion	158
5.4.1. Gender Identification Times	158
5.4.2. Percentage of Correct Recognitions	158
5.4.3. Comparison of the current study and Ridout et al (2003)	160
5.4.4. Summary and Conclusions	161

CHAPTER SIX: EMOTION RECOGNITION AND SOCIAL PERCEPTION IN MAJOR DEPRESSION: IMPAIRED INTERPRETATION OF VIDEOTAPED SOCIAL INTERACTIONS?

6.1. Introduction	163
6.1.1. Background	163
6.1.2. Processing of emotional faces in major depression	164
6.1.3. The Awareness of Social Inference Test (TASIT)	165
6.1.4. TASIT and Major Depression	166
6.1.5. Overview and Predictions	168
6.2. Method	169
6.2.1. Design	169
6.2.2. Participants	170
6.2.3. Materials and Apparatus	170
6.2.3.1. <i>The Awareness of Social Inference Test (TASIT)</i>	170
6.2.3.2. <i>Tasks Assessing Executive Processing</i>	172
6.2.3.3. <i>Assessment of Self-rated mood</i>	174
6.2.3.4. <i>Assessment of Pre-morbid Intellectual Ability</i>	174
6.2.4. Procedure	174
6.2.4.1. <i>General Assessment</i>	174
6.2.4.2. <i>The Awareness of Social Inference Test (TASIT)</i>	174
6.2.5. Data Analysis	176
6.3. Results	177
6.3.1. Participant Characteristics	177

6.3.2. Emotion Recognition	179
6.3.3. Social Inference (Minimal)	181
6.3.4. Social Inference (Enriched)	182
6.3.5. Executive Function and the Interpretation of Social Interactions	183
6.3.5.1. <i>Social Inference (minimal)</i>	183
6.3.5.2. <i>Social Inference (enriched)</i>	184
6.3.6. Depression Severity, Executive Function and Social Perception	185
6.4. Discussion	186
6.4.1. Emotion Recognition Phase	187
6.4.2. Social Inference Minimal (SIM)	188
6.4.3. Social Inference - Enriched	190
6.4.4. Executive Function and the Interpretation of Social Interactions	191
6.4.5. Depression Severity, Executive Function and Interpretation of Social interactions	192
6.4.6. Methodological Considerations	192
6.4.7. Summary and Conclusions	193

CHAPTER SEVEN: NEUROSURGERY FOR CHRONIC, TREATMENT-REFRACTORY, DEPRESSION: SUBSEQUENT IMPAIRMENT OF EMOTION RECOGNITION AND SOCIAL PERCEPTION?

7.1. Introduction	195
7.1.1. Background	195
7.1.2. Neurosurgery for Mental Disorders (NMD) in Dundee	195

7.1.3. What are the long-term consequences of neurosurgery?	196
7.1.4. Overview and Predictions	199
7.1.4.1. Hypothesis tested during Emotion Recognition (ER) phase	200
7.1.4.2. Hypothesis tested during the Social Inference (minimal; SIM & Enriched; SIE) phases	200
7.2. Method	200
7.2.1. Design	200
7.2.2. Participants	201
7.2.3. Materials and Apparatus	202
7.2.4. Procedure	203
7.2.5. Data Analysis	203
7.3. Results	204
7.3.1. Participant Characteristics	204
7.3.2. Emotion Recognition	206
7.3.3. Social Inference – Minimal (SIM)	207
7.3.4. Social Inference- Enriched (SIE)	210
7.4. Discussion	211
7.4.1. Emotion Recognition Phase	211
7.4.2. Social Inference Minimal (SIM)	212
7.4.3. Social Inference Enriched (SIE)	213
7.4.4. Methodological Considerations	214
7.4.5. Summary and Conclusions	215

CHAPTER EIGHT: GENERAL DISCUSSION

8.1. Overview	216
8.2. Selective attention for emotional material in major depression	217
8.3. Memory function and major depression	219
8.3.1. Memory for affective material in major depression	219
8.3.2. Autobiographical memory retrieval in major depression	222
8.4. Emotion recognition and social perception in major depression	224
8.4.1. Emotion recognition and MD	224
8.4.2. Social perception and MD	225
8.5. Cognitive theories of MD and the profile of emotional processing	226
8.6. Executive function, emotional processing and major depression	230
8.7. Neural underpinnings of emotion processing in MD	233
8.7.1. Anterior cingulate (AC) function and the profile of emotional processing in MD	234
8.6.2. Orbitofrontal cortex (OFC) and emotional processing in MD	235
8.6.3. Summary and conclusions: Neural correlates of emotional processing in major depression	235
8.8. Implications of the current findings	236
8.8.1. Theoretical and methodological implications	236
8.8.2. Implications for depressed individuals' everyday functioning	238
8.8.2. Implications for duration of ongoing episode	238
8.8.3. Implications for possible therapeutic intervention	239
8.9. Limitations of the current investigations	240
8.10 Future directions	240
8.11 Summary of thesis and conclusions	241

REFERENCES	244
APPENDICES	266

TABLES

CHAPTER THREE

	Page
Table 3.1: Characteristics of the individuals making up the two participant groups	76
Table 3.2: Mean valence identification time (in milliseconds), as a function of the type of facial expression upon which the words were superimposed during the selective attention task (<i>one standard error presented in parentheses</i>)	77
Table 3.3: Mean d' and β values calculated from the participants responses to the positive and negative words during recognition memory testing	95
Table 3.4: Number of participants in each group that falsely recognised the lure word "sad" (expected frequencies are shown in parentheses)	96

CHAPTER FOUR

Table 4.1: Characteristics of the individuals in the two participant groups	118
Table 4.2: Mean time (seconds) taken by the participants to retrieve specific ABMs in response to the different types of affective cues, as a function of the valence of the ABM retrieved (Standard errors presented in parentheses).	120
Table 4.3: Percentage of specific ABMs given by the participants as a first response to the different types of affective cues, as a function of the valence of the ABM retrieved (standard errors presented in parentheses).	123
Table 4.4: Mean number of each type of retrieval error committed by the participants, as a function of type of memory cue (standard errors are presented in parentheses)	127
Table 4.5: Number of ruminative and non-ruminative statements produced by the depressed patients in response to words and faces (expected frequencies are presented in parentheses).	133

CHAPTER FIVE

Page

Table 5.1: Characteristics of the individuals in each participant group	154
---	-----

CHAPTER SIX

Table 6.1: Characteristics of the individuals making up each participant group	178
Table 6.2: Percentage of correct recognitions of each type of positive emotional expression, as a function of participant group (one standard error of the mean presented in parentheses)	181

CHAPTER SEVEN

Table 7.1: Profile of the participants in the three groups	205
Table 7.2: Percentage of positive and negative emotional displays correctly recognised, as a function of depression and surgery status	207
Table 7.3: Percentage of sincere and sarcastic interactions correctly interpreted by the participants, as a function of depression and surgery status	208
Table 7.4: Percentage of social interactions correctly interpreted by the participants during the SIE phase of the study, as a function of depression and surgery status	210

FIGURES

CHAPTER ONE

PAGE

- Figure 1.1: Percentage of each type of emotional faces correctly recognised by the participants during recognition memory testing (error bars show \pm one standard error of the mean) - reproduced from Ridout et al (2003). 25

CHAPTER THREE

- Figure 3.1: An exemplar of the compound stimuli presented to the participants during the selective attention task 71
- Figure 3.2: Mean valence identification times for the positive and negative words paired with happy, neutral and sad faces (error bars represent \pm one standard error of the mean) 78
- Figure 3.3: Mean valence identification times for the positive words paired with happy, neutral and sad faces, as a function of participant group (error bars represent \pm one standard error of the mean) 80
- Figure 3.4: Mean valence identification times for the negative words paired with happy, neutral and sad faces, as a function of participant group (error bars represent \pm one standard error of the mean) 81
- Figure 3.5: Mean valence identification times for the neutral words paired with happy, neutral and sad faces, as a function of participant group (error bars represent \pm one standard error of the mean) 82
- Figure 3.6: Mean percentage of positive and negative word identification errors made by the depressed patients, as a function of face valence (error bars represent \pm one standard error of the mean) 87

CHAPTER THREE (Continued...)

PAGE

Figure 3.7: Percentage of positive and negative words correctly recognised by the participants during recognition memory testing	92
--	----

CHAPTER FOUR

Figure 4.1: Mean time (in seconds) taken by the participants to retrieve a specific ABM, as a function of type of memory cue (error bars represent \pm one standard error of the mean)	121
Figure 4.2: Mean time in seconds taken by the participants to retrieve positive and negative ABMs (error bars represent \pm one standard error of the mean)	122
Figure 4.3: Percentage of specific ABM retrieved the different cues, as a function of participant group (error bars represent \pm one standard error of the mean)	124
Figure 4.4: Percentage of specific positive and negative ABMs retrieved, as a function of participant group (error bars represent \pm one standard error of the mean)	125
Figure 4.5: Mean number of retrieval errors, as a function of participant group (error bars represent \pm one standard error of the mean)	128
Figure 4.6: Mean number of categorical errors committed by the participants, as a function of cue type (error bars represent \pm one standard error of the mean)	130

CHAPTER FIVE

Figure 5.1: Percentage of each type of emotional face correctly recognised by the participants during recognition memory testing (error bars show \pm one standard error of the mean) - reproduced from Ridout et al (2003).	144
--	-----

CHAPTER FIVE (continued...)

PAGE

- Figure 5.2. Mean gender identification times of the participants, as a function of the valence of emotional expression portrayed in the photographs (error bars show \pm one standard error of the mean) 156
- Figure 5.3: Percentage of faces correctly recognised by the participants, as a function of the valence of the faces (error bars show \pm one standard error of the mean) 157
- Figure 5.4: Comparison of the pattern of recognition memory exhibited by the participants (depressed & controls) in (A) Ridout et al (2003) and (B) the current study 160

CHAPTER SIX

- Figure 6.1: Percentage of positive and negative emotional displays correctly identified, as a function of participant group (error bars represent \pm one standard error of the mean) 180
- Figure 6.2. Percentage of social interactions correctly interpreted during the social inference (minimal) phase, as a function of participant group (error bars represent \pm one standard error of the mean) 182
- Figure 6.3. Percentage of social interactions correctly interpreted during the social inference (enriched phase), as a function of participant group (error bars represent \pm one standard error of the mean) 183

CHAPTER SEVEN

- Figure 7.1: Percentage of sarcastic interactions correctly interpreted by the participants during the SIM phase, as a function of their depression and surgery status (error bars represent \pm one standard error of the mean). 209

PUBLICATIONS ARISING FROM THE THESIS

Ridout, N., Reid, I., Matthews, K., & O' Carroll (2004) *Emotion recognition and social perception in patients one year after undergoing a surgical intervention for chronic refractory depression* Proceedings of the BPS, 12 (1) page 3

Ridout, N., Dritschel, B., Matthews, K., & O' Carroll, R. E. (2004) *Neurosurgery for chronic, treatment-refractory, depression: Subsequent deficits in emotion recognition and social perception?* Proceedings of the BPS, 12 (1) page 71

Ridout, N., Dritschel, B. H., Matthews, K., Reid, I. C., Day, R., & O' Carroll, R. E. (2004) *Selective processing of emotional faces in major depression: evidence from a face/word variant of the emotional Stroop task.* Cognition and Emotion (in review)

Ridout, N., O' Carroll, R. E., Matthews, K., Reid, I. C., Christmas, D., & Dritschel, B. H. (2004) *Autobiographical memory in major depression: Different responses to visual and verbal affective cues?* Journal of Abnormal Psychology (submitted)

Ridout, N., Dritschel, B. H., Matthews, K., Curran, S., & O' Carroll, R. E. (2005) *Memory bias for sad faces in major depression: does it require explicit processing of emotion at encoding?* Cognition and Emotion (submitted)

Ridout, N., Dritschel, B., Matthews, K., Morrison, C., & O' Carroll, R.E. (2004) *Neurosurgery for chronic, treatment-refractory, depression: Subsequent deficits in emotion recognition and social perception?* Neuropsychologia (in prep)

OVERVIEW OF THE EXPERIMENTAL CHAPTERS OF THIS THESIS

CHAPTER THREE

Previous studies utilising emotional versions of the Stroop colour-naming task (e.g. Gotlib & Cane, 1987) have reported that clinically depressed individuals exhibit a selective attention bias towards depression-relevant words, evidenced by slower colour naming times for these words compared to positive or neutral words. The experiment reported in chapter three extended this work by utilising a face-word variant of the emotional Stroop task in order to establish if automatic processing of emotional faces would influence concurrent processing of, and subsequent memory for, a series of affective words. Of particular interest was whether clinically depressed patients would exhibit an attention bias for sad faces. In this study, participants were presented with affective words superimposed across photographs of emotional facial expressions and were required to ignore the faces and to identify the valence of the words. Participants were subsequently given a recognition memory test for the words they had viewed during the valence identification task. Contrary to predictions, depressed individuals did not selectively attend towards distracting sad faces. However, healthy controls demonstrated biased attention towards happy faces. Overall, depressed patients demonstrated a deficit in their ability to ignore the distracting faces, evidenced by slower valence identification times for incongruent face/word pairs relative to congruent pairs. Analysis of the accuracy of word-valence identification revealed that depressed individuals exhibited more accurate identification of depression-relevant words compared to other word types. During

recognition memory testing for the words, the depressed individuals did not demonstrate the predicted mood-congruent memory bias for depression-relevant words. However, they did demonstrate a significant tendency to falsely recognise depression-relevant words that had not been presented during the encoding phase. In contrast, there was some evidence to suggest that the controls demonstrated superior recognition memory for positive words. However, this may have been a consequence of a positive word response bias on the part of the controls, as this pattern was no longer evident when signal detection analysis was conducted to assess the participants 'pure' memory for the words.

CHAPTER FOUR

Previous studies have consistently reported that major depression is associated with marked changes in the retrieval of autobiographical memories. For example, many studies have demonstrated that depression is related to greater accessibility of negative memories relative to positive, usually as a result of impaired retrieval of positive memories (see Williams, 1996). Furthermore, numerous studies (e.g. Kuyken & Brewin, 1995; Moore, Watts & Williams, 1988; Williams & Dritschel, 1988; Williams & Scott, 1988) have reported that, when requested to retrieve specific memories of autobiographical events, depressed individuals tend to retrieve overgeneral, categorical memories. The experiment reported in chapter four extended this work by comparing the pattern of ABM retrieval associated with the traditional verbal cueing task and two novel non-verbal cueing tasks, where participants were cued with emotional faces and affective images. Participants were presented with three blocks of memory cues (words, images & faces) in a counterbalanced order and were required to retrieve a specific memory of an event from their past in response to

each cue. The participants were also asked to rate the pleasantness of each memory they retrieved. As expected, depressed patients were significantly slower than healthy controls to retrieve specific positive memories, but did not differ from the controls in terms of the time taken to produce negative memories. Also as expected, depressed individuals retrieved significantly fewer specific ABMs than did the controls. Inspection of the participants' retrieval errors revealed that the reduction in ABM specificity exhibited by the depressed patients was a consequence of a marked increase in the retrieval of generic categorical memories. As expected, participants retrieved significantly more specific memories to image cues than to faces or words. This finding is consistent with Williams et al (1999) who reported that highly imageable word cues produced greater ABM specificity than did less imageable words. However, in the current study, the specificity advantage for images was only observed in the healthy controls. This finding is consistent with Williams and Dritschel (1988), who reported that clinically depressed individuals were unable to make use of additional contextual information to enhance their access to specific ABMs. Interestingly, in the current study, the tendency on the part of the depressed patients to retrieve generic memories was particularly marked when they were required to retrieve memories to face cues, compared to words or images. One plausible explanation of this finding is that the faces were inducing rumination in the depressed patients. Content analysis of the retrieved memories provided some support for this proposition. It is also possible that this finding was a consequence of differences in the relative cognitive demands of ABM retrieval to the faces compared to the other cue types. Inspection of the participants' retrieval times revealed that, relative to words and images, faces required longer processing to produce specific ABMs, suggesting that retrieval to faces required greater cognitive capacity. It is

generally accepted that depressed individuals have reduced cognitive capacity relative to healthy individuals, thus it would be expected that any increase in cognitive demand would have exerted a greater impact on the ABM retrieval of depressed patients, than that of the controls.

CHAPTER FIVE

Previous research has consistently demonstrated that depressed individuals exhibit a marked mood-congruent memory (MCM) bias for depression-relevant words. A recent study (Ridout, Astell, Reid, Glen & O' Carroll, 2003) extended this work by demonstrating that this MCM bias generalises to depressed individuals' memory for emotional facial expressions. The aim of the experiment reported in chapter five of this thesis was to establish if the observed MCM bias for sad faces in major depression was dependent upon explicit processing of face valence during encoding. In the previous study (Ridout et al, 2003) the task completed by the participants during encoding phase was a valence identification task, which clearly required explicit processing of face valence. In contrast, a gender identification task was utilised during the initial phase of the current study, which would not have required explicit processing of face valence. Participants were presented with a series of photographs of different people (who were posed in different emotional expressions) and were asked to identify the gender of the people featured in the photographs. Inspection of the gender identification times revealed that the emotional expression featured in the photographs did not influence the speed of gender identification. Furthermore, inspection of the recognition memory data revealed that depressed individuals did not demonstrate the expected MCM bias for the sad faces, suggesting that such memory biases are dependent upon explicit processing of emotional valence

at encoding. This notion is consistent with Teasdale and Barnard's Interacting Cognitive Subsystems (ICS) model (1993).

CHAPTER SIX

Previous research has demonstrated that clinical depression is associated with changes in emotion recognition from faces (e.g. Persad & Polivy, 1993). Furthermore, a number of studies (e.g. Ambady & Gray, 2002) have reported that depression is associated with impairments to social perception. The experiment reported in chapter six extended this work by utilising a novel test of emotion recognition and social perception (The Awareness of Social Inference Test; TASIT). In the Emotion Evaluation (EE) phase of TASIT, participants are presented with videotaped depictions of realistic social interactions and are required to identify the emotion portrayed by the individuals featured in the video clips. In the Social Inference (SI) phase, participants are presented with further video clips and are required to make inferences about the thoughts, feelings, beliefs and intentions of the featured protagonists. In the EE phase of the current study, clinically depressed individuals did not exhibit a general deficit in emotion recognition, relative to healthy controls. However, subsequent analysis of the participants' recognition of the individual emotional expressions revealed that they did exhibit a specific impairment in their recognition of happiness. In the SI phase of the current study, patients with major depression demonstrated impaired interpretation of social interactions involving sarcasm and deception, but were unimpaired in their interpretation of sincere social interactions, relative to healthy controls. Correct interpretation of social interactions involving sarcasm and deception was significantly related to both depression severity (indexed by the BDI scores) and central executive function (indexed by performance

on the Stroop and Hayling's tasks). A plausible explanation of these findings is that depression reduced the capacity of available cognitive resources that could be applied to perform the executive tasks and to interpret the social interactions. However, as the relationship between executive function and social inference persisted even after controlling for depression severity, it would seem likely that successful social inference relies, at least in part, upon intact executive function.

CHAPTER SEVEN

The aim of the experiment reported in chapter seven was to establish if neurosurgical interventions for chronic, treatment-refractory depression were associated with subsequent impairments in emotion recognition and social perception. The current study involved assessing a group of patients, around one year after they had undergone a neurosurgical intervention for chronic, treatment-resistant depression, on the same test of emotion recognition and social perception (TASIT) that was utilised in the study reported in chapter six. The depressed patients and healthy controls from the previous study were included in the current study as clinical and healthy control groups for the surgery patients. The findings reported in chapter six suggested a role for the central executive in successful social inference, evidenced by strong relationships between successful social interpretation and performance on the Stroop and Hayling's tasks. Previous studies have implicated the anterior cingulate (AC) region of the prefrontal cortex in the performance of these executive tasks. Furthermore, Hornack et al (2003) reported that lesions to the AC were associated with impaired emotion recognition from faces and voices. As it has been demonstrated that major depression is associated with dysfunction of the AC it is plausible that the deficits in social inference and executive performance exhibited by

the depressed patients in the previous chapter might relate to the changes in function of the AC in these patients. Based on this assumption it was expected that the surgery patients in the current study would demonstrate similar impairment of emotion recognition and social processing, as the majority (seven out of eight) of the surgery patients in the current study had undergone an anterior cingulotomy (involving bilateral lesions to the anterior cingulate). The remaining surgery patient had undergone an anterior capsulotomy, which involves the disconnection of the orbitofrontal cortex from important regions of the limbic system (e.g. the thalamus). As Hornack et al (2003) reported that disruption to the function of the OFC was also associated with impaired emotion recognition from faces and voices, it was expected that this patient would also demonstrate deficits on TASIT. In the emotion evaluation phase of the current study surgery patients demonstrated a general impairment of emotion recognition, in contrast to the depressed patients' specific deficit in the recognition of happiness. In the social inference phases, surgery patients exhibited a general impairment in their social perception. Importantly, although both depression and surgery were associated with deficits in emotion recognition and social perception there was no interaction between these two factors. The findings suggest that the observed deficits in emotional processing related to a disruption of the normal functioning of the anterior cingulate and/or orbitofrontal cortex, either as a consequence of depression or surgical lesion. However, although both depression and surgical intervention were associated with impaired emotional processing, and presumably AC/ OFC function, they resulted in a differential pattern of impairment. Moreover, the presence of depressive symptoms in patients that had undergone surgery did not appear to further impair the emotional processing of these individuals.

-CHAPTER ONE-

GENERAL INTRODUCTION

1.1. Background

Major depression (MD), also referred to as clinical depression, is the most common of all of the psychological disorders, with an estimated 5% of US and European populations suffering from MD at any one time (Blazer, Kessler, McGonagle & Swartz, 1994; Smith & Weissman, 1992), and with approximately one in five of the individuals in these populations suffering from MD at some point in their lives (cited in Hammen, 1997). Furthermore, according to the World Health Organisation (WHO), clinical depression is currently considered the fourth biggest cause of disability and premature death around the world, and is predicted to become the second biggest cause by the year 2020 (Murray & Lopez, 1996). From these findings it is clear that MD represents a common and extremely serious condition that warrants considerable research effort.

According to the fourth edition of Diagnostic and Statistical Manual (DSM-IV; American Psychiatric Association, 1994) and the tenth version of the International Classification of Diseases (ICD-10; WHO, 1993) the core feature of MD is a striking disturbance of mood. This disruption manifests itself most notably as feelings of intense sadness (or 'emptiness') that are usually coupled with marked anhedonia (loss of pleasure in life's activities). Importantly, in MD these feelings are seen to persist over a number of weeks, months or even years (the diagnosis of major depression will be considered in more depth in the next chapter, page 46).

Despite clear evidence that depression is associated with marked changes in brain chemistry (see Hammen, 1997), MD can also be usefully conceived of as a disorder of thinking. For example, it is common for depressed individuals to report that they believe their current depression to be a punishment for something they have done in the past. Such guilt-ridden, self-critical thinking has been shown to persist in depressed individuals even after these beliefs have been challenged by clinicians or the patient's significant others (e.g. spouse). Many researchers (e.g. Beck, 1967; Teasdale, 1983) have argued that the changes in thinking that are associated with clinical depression could play a central role in maintaining the ongoing depressive episode, and furthermore, might even be involved in the initial onset of MD. With this in mind, the last three decades have witnessed increasing interest in the cognitive aspects of clinical depression (see Murphy, Sahakian and O' Carroll, 1998). The majority of this research has tended to follow one of two approaches. Studies have either examined depressed individuals' performance on standard tests that address elements of general cognitive functioning (e.g. learning, memory, attention, problem-solving etc) or else they have been concerned with changes in the processing of emotionally valenced material that are associated with major depression. Although these approaches have been conducted relatively independently of one another, it would seem clear that an understanding of the pattern of general cognitive impairment in MD could contribute to explanations of the observed changes in the processing of emotionally valenced material. Similarly, awareness of how MD influences the processing of affective material might also facilitate greater understanding of how depression impairs normal cognitive function.

The experimental studies that will form the core of this thesis will primarily take the latter approach of those outlined above (i.e. they will examine the processing of emotional material), however, in explaining the pattern of findings observed in each study, reference will be made to previous work concerning general cognitive impairment that is associated with MD. Furthermore, evidence concerning the possible neural underpinnings of the observed cognitive changes will also be considered. The next two sections of this chapter will provide an outline of the profile of general cognitive impairment that is associated with major depression and consider possible factors underlying this pattern of impairment. The subsequent two sections will then provide an overview of the central findings concerning the processing of affective material in MD and provide an overview of the principal cognitive theories of clinical depression, with particular focus on how these theories account for the observed changes in emotional processing. The subsequent section will consider possible neural underpinnings of major depression, including the associated pattern of cognitive impairment and the observed profile of emotional processing. Finally an outline of the principal aims of the thesis will be presented, including an overview of the central research questions.

1.2. General cognitive impairment in MD

Despite the fact that both the DSM-IV and ICD-10 include reference to problems with concentration, thinking and decision-making in their diagnostic criteria for major depression, initial investigations into this area (e.g. Friedman, 1964) suggested that depression was only associated with mild impairment of cognitive function. However, this position was challenged by Miller (1975) who concluded, based on a review of the available evidence, that depression was associated with deficits in a variety of

cognitive domains. Despite this work, the full extent of cognitive impairment associated with major depression has only been established fairly recently. For example, it has been reported on a number of occasions that the impairment of cognitive function associated with clinical depression could be so marked that depressed individuals were indistinguishable from patients with organic dementias (e.g. O' Carroll, Conway, Ryman & Prentice, 1997). The evidence that individuals suffering from major depression exhibit impaired functioning of a variety of cognitive processes, most notably speed of processing, memory, attention and 'executive' function will be considered in the subsequent sub-sections (1.2.1 to 1.2.4.).

1.2.1. Cognitive and psychomotor retardation in MD

A primary deficit that has been consistently demonstrated in the performance of depressed individuals on a myriad of cognitive tasks has been a marked slowing of cognitive and psychomotor speed (see Williams, Watts, MacLeod & Mathews, 1997). For example, it has been reported on numerous occasions that depressed individuals exhibit impaired performance on simple reaction time (SRT) tasks (e.g. Austin et al, 1999; Moffoot et al, 1994). Similar deficits have been reported on choice reaction time performance (e.g. Tarbuck & Paykel, 1995). Further evidence of marked psychomotor slowing in depressed patients comes from numerous studies (e.g. Austin et al, 1999; Ilsley, Moffoot & O' Carroll, 1995; Ridout, Astell, Glen, Reid & O' Carroll, 2003) reporting that major depression is associated with impaired performance on the digit symbol substitution task (DSST) from the revised Wechsler Adult Intelligence Scale (WAIS-R; Wechsler, 1981). However, as noted by Mialet, Pope and Yurgelun-Todd (1996), although these tasks are, to some extent, measures of cognitive speed they also involve a motor component. Psychomotor retardation is

highly characteristic of depressive states, thus it would seem likely that at least some of the deficit in performance on these tasks relates to this psychomotor retardation. Despite this likelihood, Tsourtos, Thompson and Stough (2002) reported that, relative to non-depressed matched controls, un-medicated depressed individuals were slowed on a measure of speed of information processing (inspection time; IT) that did not require a speeded motor response. Thus there is some evidence, at least for un-medicated patients, to suggest that information processing is slowed, as a consequence of depression. However, it is important to note that psychomotor retardation is not specific to depression, as it has been reported in previous studies (e.g. Miller, 1975) that it was not possible to distinguish between depressed and schizophrenic patients on standard cognitive tests that involve motor and/or cognitive speed. However, it is clear that when assessing depressed individuals' cognitive function there is a need to control for the deficits in performance that could be explained simply in terms of this cognitive/motor slowing.

1.2.2. Memory function in MD

There have been a vast number of studies reporting deficits in mnemonic function in depressed patients. Tarbuck and Paykel (1995) for example, reported that depressed individuals were significantly impaired, relative to matched controls, on all elements of the Rivermead Behavioural Memory Test (RBMT, Wilson et al, 1985), which is a standardised method of assessing everyday memory function. Furthermore, numerous studies have reported that depression is associated with impaired memory for previously learned words. This finding has been particularly robust in studies that have utilised recall tasks (e.g. Brown, Scott, Bench & Dolan, 1994; Golinkoff & Sweeney, 1989; Ilsley, Moffoot & O'Carroll, 1995) but has also been demonstrated in

studies incorporating tests of recognition memory (e.g. Austin et al, 1999; Brown et al, 1994; Golinkoff & Sweeney, 1989) and also cued recall tasks, such as paired-associate learning (e.g. Brown et al, 1994; Golinkoff & Sweeney, 1989). In addition to the memory deficits that have been reported using verbal stimuli, recognition memory deficits have been also been reported in studies using visual stimuli. For example, a number of researchers have demonstrated impaired memory for abstract patterns (e.g. Abas, Sahakian & Levy, 1990; Elliott et al, 1996). In particular, it has been reported consistently (e.g. Elliot, Sahakian, Herrod, Robbins & Paykel, 1997; Elliot et al, 1996; Moffoot et al, 1994; Shah, O' Carroll, Rogers, Moffoot & Ebmeier, 1999) that depressed individuals are impaired on the delayed matching to sample task (DMTS), which is a controlled test of pattern recognition that is part of the Cambridge Neuropsychological Test Automated Battery (CANTAB; Morris et al, 1987). In addition, depressed individuals have been shown to exhibit deficits in recognition memory for previously viewed faces (e.g. Brown et al, 1994; Palmer et al, 1996). Despite the consistency of these findings, it should be noted that a number of studies have failed to demonstrate impaired recognition memory in depressed patients (e.g. Ilsley et al, 1995; Purcell, Maruff, Kyrios & Pantelis, 1997).

Another area of memory that has been the focus of considerable study has been short term/working memory function. There have been numerous studies (e.g. Abas, Sahakian & Levy, 1990; McAllister, 1981) reporting significant deficits in depressed individuals' performance on tests assessing this area of memory function. Further supportive evidence of a working memory deficit in depressed individuals comes from several studies that have reported impaired performance on the digit span task (e.g. Austin et al, 1999; Moffoot et al, 1994; Ridout et al, 2003). Similarly, research

(e.g. Abas et al, 1990; Elliott et al, 1996) reporting impaired performance on the spatial span task also provides support for the notion that major depression is associated with a disruption of working memory function. However, it should be noted, there have been a number of studies that have failed to demonstrate impaired working memory function in depressed patients (e.g. Ilsley et al, 1995; Purcell et al, 1997). Nevertheless, despite these findings, the weight of evidence supports a wide-ranging impairment of mnemonic function in major depression. This phenomenon will be considered further when the possible factors influencing these cognitive impairments are discussed (section 1.3, page 11).

1.2.3. Attention and concentration in MD

As noted by Mialet, Pope and Yurgelun-Todd (1996), in comparison to the vast number of studies addressing mnemonic function in major depression, there has been a relatively limited investigation of the changes in attentional processing that are related to clinical depression. This is surprising considering that depressed individuals often report considerable problems in their ability to concentrate (e.g. to read a newspaper). Studies that have been conducted have provided consistent evidence that major depression is associated with marked dysfunction of various aspects of attentional processing. For example, Mialet et al (1996) reported that, in terms of the initial 'alerting' stage of attention, depressed individuals exhibit a reduction in receptivity to incoming stimuli (e.g. indexed by longer initial processing time). Furthermore, a number of studies (e.g. Elliott et al, 1997; Shah et al, 1999) have reported that depressed individuals were less accurate in identifying targets on the simultaneous matching to sample element (SMTS) of CANTAB, a task that is best conceptualised as a measure of concentration and attention. There is also some

evidence to suggest that clinical depression is associated with impaired vigilance and sustained attention (see Christensen, Griffiths, MacKinnon & Jacomb, 1997). There is also good evidence that deficits in focused attention contribute to the impairment in verbal recall that is associated with major depression. For example, Hertel and Rude (1991) demonstrated that when encoding conditions did not encourage focused attention depressed individuals' recall of words was significantly poorer than matched controls. However, if the encoding instructions constrained participants to focus their attention on the words then the recall performance of the depressed patients was indistinguishable from that of the controls. From the above it is clear that depression is associated with deficits in many areas of normal attentional function. However, considering the character of everyday attentional problems that are reported by depressed individuals (e.g. an inability to concentrate sufficiently to read a book or to watch a television programme) it would seem that studies addressing selective attention might provide a clearer understanding of how clinical depression affects attention.

There have been a number of studies addressing elements of selective attention in depression. For example, there is considerable evidence that, relative to healthy controls, depressed individuals are impaired on the Stroop colour-naming task (e.g. Lamelin, Baruch, Vincent, Everett & Vincent, 1997; Trichard et al, 1995). In the traditional Stroop task participants are required to name the colour of ink in which a series of stimuli are presented. The most common finding is that participants are markedly slower to name the colour of ink when the stimuli are incongruent colour words (e.g. the word RED printed in green ink) than when they are nouns (e.g. the word TABLE printed in green ink) or letter strings (e.g. a row of X's printed in green

ink). This finding is commonly referred to as the Stroop effect (Macleod, 1991). The Stroop task is usually considered to be a measure of selective attention. However, there have been a number of theories proposed to account for the observed slowing in colour naming. The most common account is that automatic processing of word meaning interferes with colour naming. The Stroop task is also considered to be an executive task, as it requires controlled allocation of attention. A number of studies have reported increased interference from incongruent colour names in participants with frontal lobe damage (Swick & Jovanovic, 2002). Furthermore, there have been a number of functional imaging studies that have demonstrated increased activation in brain regions considered to be involved in executive processing (e.g. anterior cingulate; AC) during the performance of the traditional Stroop task (e.g. Pardo, Pardo, Janer & Raichle, 1990). However, it should be noted that, there have been a number of theories concerning the role of the AC in Stroop performance; including resource allocation, response selection and conflict monitoring. The common finding is that, relative to healthy controls, major depression is associated with increased interference from incongruent colour words on this task. However, Lamelin et al (1997) concluded that impaired performance on the Stroop task in depression might be a consequence of two different attentional deficits; some patients may exhibit impaired distracter inhibition and others may have deficient processing resources available. The notion of differences in available cognitive resources will be discussed further in section 1.3 (page 11) when the possible factors underlying cognitive impairment in MD are considered. Further evidence that major depression is associated with impaired distracter inhibition comes from MacQueen, Tipper, Young, Joffe & Levitt (2000), who reported that depressed individuals failed to inhibit

distracting “off task” stimuli when they were asked to respond to the target “on task” stimuli.

1.2.4. ‘Executive’ function in MD

A further domain of cognitive function that has been the subject of considerable research interest, in terms of the influence of major depression on cognitive function, is that of the so-called ‘executive’ function. ‘Executive’ function refers to the higher-level cognitive processes (e.g. planning, reasoning & problem-solving) that require organisation, control and allocation of cognitive resources (Channon, 1996). This important system has been postulated in a number of influential models of cognitive function. For example, the ‘central executive’ element of working memory proposed by Baddeley and Hitch (1974) or the ‘attentional supervisor’ proposed by Norman and Shallice (1986) in their model of attention. There is considerable evidence to suggest that clinical depression is associated with impaired ‘executive’ function. For example, numerous studies have demonstrated impaired verbal fluency in depressed patients (e.g. Brown et al, 1994; Elliott et al, 1998; Porterfield, Cook, Deary & Ebmeier, 1997; Trichard et al, 1995). However, it should be noted that this impairment could be due to the presence of psychomotor/cognitive slowing in the depressed patients (outlined above in 1.2.1, page 4).

Further evidence of ‘executive’ dysfunction in major depression comes from a number of studies reporting that depressed individuals are impaired on tasks that assess planning, such as the Towers of London task from CANTAB (e.g. Elliot et al, 1996; Elliott et al, 1997; Purcell et al, 1997) or multiple scheduling tasks (e.g. Channon & Green, 1999). A widely utilised neuropsychological test that is considered

to tap 'executive function' is the Wisconsin card-sorting task (WCST; Heaton, 1981). A vast number of studies have demonstrated impaired WCST performance in clinically depressed individuals (e.g. Austin et al, 1999; Channon, 1996; Degl'Innocenti, Ågren & Bäckman, 1998; Palmer et al, 1996). Inspection of the findings of these studies suggests that, relative to healthy individuals, depressed patients tend to take longer to learn the sorting rules, to complete fewer sorting categories, take more trials to complete each sorting category, and most notably to make more perseverative errors (i.e. continue to apply a sorting rule when it is no longer appropriate to do so). Other tasks that have been utilised in studies demonstrating impaired 'executive' function in depressed individuals include the Hayling's sentence completion task (Channon & Green, 1999), the symbol cancellation task (Tarbuck & Paykel, 1995; Trichard et al, 1995), frequency judgement task (Golinkoff & Sweeney, 1989) and the silly sentences task (Tarbuck & Paykel, 1995). Taken together these findings indicate that clinical depression is associated with extensive impairment of 'executive' function.

1.3. Possible factors influencing cognitive impairment in MD

1.3.1. Depression severity

There have been numerous studies that have assessed the extent to which any observed cognitive impairment was associated with the severity of depressive symptoms. For example, Elliott et al (1996) reported that degree of cognitive impairment was significantly associated with clinical ratings of depression severity; these findings were particularly apparent for memory function. Similarly, a number of reviews of cognitive function in depressed patients have reported relationships between depression severity and cognitive impairment (e.g. Christensen et al, 1997;

Hartlage, Alloy, Vázquez & Dykman, 1993; Johnson & Magaro, 1987; and McAllister, 1981). However, it should be noted that a considerable number of studies have failed to report significant relationships between cognitive performance and depression severity (e.g. Brown et al, 1994; Channon & Green, 1999; Degl'Innocenti et al, 1998; Golinkoff & Sweeney, 1989; Ilsley et al., 1995).

Taken together these findings suggest that there is some evidence to support a relationship between the severity of participants' depression and their performance on a variety of cognitive tasks but it is far from a universal finding. As noted by Elliott (1998), this discrepancy might relate, in part, to the measures of depression severity utilised in the different studies. Some measures (e.g. the Montgomery and Asberg Depression Rating Scale; MADRS, Montgomery & Asberg, 1979) have elements of the scale that refer explicitly to cognitive function and so would be likely to be related to any observed impairment, whereas other measures (e.g. the Hamilton Rating Scale for Depression; HRSD, Hamilton, 1960) do not include such items and so might be less likely to be associated with cognitive deficits.

1.3.2. Task demands

It has been proposed that depressed patients demonstrate greater cognitive impairment on tasks that require the application of cognitive effort than on tasks that require little or no cognitive effort, i.e. automatic processing (Hartlage et al, 1993; Hasher & Zacks, 1979). Evidence for this position comes from studies (e.g. Ilsley et al, 1995) that have demonstrated impaired recall but intact recognition memory performance in depressed individuals, as it has been suggested that recall tasks require greater cognitive effort than do tests of recognition memory (e.g. Weingartner & Silberman,

1982). Further evidence comes from studies reporting deficits in explicit memory but normal implicit memory performance (e.g. Denny & Hunt, 1992). Perhaps the strongest evidence is that depressed individuals have been consistently shown (e.g. Austin et al, 1999; Channon & Green, 1999) to exhibit impaired performance on 'executive' tasks, which are clearly extremely cognitively demanding. It should be noted, that there have been some studies that do fit with the notion that depression selectively impairs effortful processing. For example, Christensen et al (1997) reported, in their review of cognitive function in depression, that patients did not differ in terms of the deficits they exhibited on recall or recognition tasks. However, in general there would appear to be strong support for the notion that depression selectively affects effortful as opposed to automatic processing.

1.3.3. Processing resources

Hasher and Zacks (1979) were the first theorists to suggest that depression might reduce the capacity of available cognitive resources. This notion was supported by Roy-Byrne et al (1986) who proposed that this effect is mediated by the way depression interferes with the function of the neural systems utilising dopamine. However, other researchers (e.g. Ingram & Wisnicki, 1991) have argued that cognitive capacity is not altered in depression, but rather observed deficits are related to the patients narrowing the focus of their attention towards task irrelevant thoughts in general, or depression-relevant thoughts in particular. Finally, both of these propositions have been combined in the model of attention outlined by Ellis and Ashbrook (1988) that asserts that depression is associated with both reduced cognitive capacity and a narrowing of attentional focus towards primarily depression-relevant thoughts. The debate concerning the effect of depression on cognitive capacity is still

ongoing, however the strongest evidence would seem to support the combined model proposed by Ellis and Ashbrook (1988). For more detailed coverage of the evidence concerning these different positions see the review conducted by Hartlage et al (1993). However, the notion that depressed individuals are preoccupied with depression-relevant thoughts will be returned to in the sub-section (1.3.5, page 15) discussing the influence of rumination on cognitive performance.

1.3.4. Motivation

Considering that "*loss of interest*" is one of the diagnostic criteria for major depression on both the DSM-IV and ICD-10 it would seem likely that a lack of motivation on the part of depressed individuals would at least contribute to well-reported cognitive deficits associated with this condition. There is some support for this notion (e.g. Schmand et al, 1994). However, a study conducted by Richards and Ruff (1989) reported that direct manipulation of the levels of motivation had little or no effect on the level of observed cognitive performance. Elliot et al (1997) argued that it was important to distinguish between different aspects of motivation. According to these researchers, an important element of motivation in terms of major depression is the response to reinforcement. They demonstrated that the probability of a depressed individual making an error was significantly increased on a trial that followed a previous error. This finding corresponded with the results of Beats et al (1996) who also demonstrated a rapid deterioration of performance on an 'executive' task (towers of London) once the depressed patients had committed an error. These results have been interpreted as evidence that depression is associated with a "catastrophic response to perceived failure". However, it should be noted that Shah et al (1999) attempted to replicate these findings in two samples of depressed patients

and failed to observe such a devastating deterioration of performance following negative feedback in either sample. They proposed that the abnormal response to failure feedback might be a characteristic a subgroup of depressed patients.

1.3.5. Rumination

Rumination can be defined as *"the focusing of one's thoughts on one's current mood, the causes of one's depressive symptoms and worrying about the implications of one's depressive symptoms"* (Watkins & Brown, 2002). This type of analytical thinking style is characteristic of many depressed individuals, and is particularly common amongst females (Nolen-Hoeksema, 1991). Rumination has been shown to intensify patients' depression and to interfere with their ability to actively solve problems they encounter in their day-to-day life. With this in mind, it would seem likely that ruminative thinking style would interfere with the patients' ability to perform the type of cognitive tasks that were outlined in the previous sections. In line with this notion, a number of studies have reported that the ruminative response style is associated with impaired cognitive performance. For example, Watkins and Brown (2002) assessed clinically depressed patients and healthy controls on a measure of 'executive' function (random number generation task) following both a rumination and distraction manipulation. Following the rumination manipulation depressed individuals' performance was significantly impaired relative to the controls. However, following distraction (which acts to prevent rumination) the performance of the two groups was indistinguishable. It is clear from these findings that rumination interferes with the performance of cognitive tasks, possibly by reducing the availability of cognitive resources that can be applied to the task in hand.

1.3.6. Other potential influences on cognitive impairment in MD

There are a number of other factors that have been shown to exert an influence on cognitive performance and, hence, need to be controlled for in studies addressing the effect of depression on tasks that involve cognitive functions such as memory. The first of these is age, as a number of studies have reported that it can have a negative impact on cognitive functioning, and has even been shown in some studies to interact with the effects of depression. The second factor is general intellectual ability; it would seem obvious that the basic cognitive functions involved in the types of tasks utilised to investigate emotional processing would be influenced by the participants' general intelligence. Finally, there are a great many studies indicating that anxiety is also associated with changes in cognitive function (see Williams et al, 1997; Wells & Matthews, 1994). In particular there is good evidence that anxiety impairs attentional function. For example, Broadbent, Broadbent and Jones (1986) reported deficits in the performance of anxious patients on tasks assessing focused attention. Similarly, Mathews et al (1990) reported problems with attentional control in anxious participants. Major depression is commonly accompanied by marked anxiety with some studies reporting a co-morbidity rate of around 56% (Mineka, Watson & Clark, 1998). With this in mind, it is important when assessing the processing of emotional material in depression individuals to distinguish effects on processing that are related to depression from those that are a consequence of co-morbid anxiety.

1.4. Processing of emotional material in MD

1.4.1. Memory for emotional material in MD

In line with the investigation of general cognitive impairment (outlined in section 1.2, page 3) the bulk of studies addressing processing of emotional material in major

depression have tended to focus on memory function. These studies have been inclined to take one of two approaches. Studies have either looked at changes in depressed individuals ability to retrieve memories of events from their own lives (i.e. autobiographical memories) or else they have assessed depressed patients' memory for emotionally valenced experimental material (e.g. affective words). The next two sub-sections will consider the wealth of evidence that has resulted from these two approaches.

1.4.1.1. Autobiographical memory (ABM) in MD

There is a wealth of evidence suggesting that major depression is associated with changes to autobiographical memory function. For example, many studies have demonstrated that depression is related to greater accessibility of negative memories relative to positive, usually as a result of impaired retrieval of positive memories (see Williams, 1996). This tendency has been demonstrated in both the speed of retrieval (e.g. Lloyd & Lishman, 1975) and in terms of the proportion of positive and negative memories retrieved (e.g. Clark & Teasdale, 1982). In addition to changes in the relative accessibility of different memories, numerous studies (e.g. Kuyken & Brewin, 1995; Moore, Watts & Williams, 1988; Williams & Dritschel, 1988; Williams & Scott, 1988) have reported that, when requested to retrieve specific memories of autobiographical events, depressed individuals are more likely than non-depressed controls to retrieve overgeneral memories. Williams and Dritschel (1992) conducted a detailed analysis of the types of ABMs produced by depressed patients and identified two forms of general ABM; extended memories (that last longer than one day, e.g. *being on holiday in Spain two years ago*) and categorical memories (summaries of repeated events, e.g. *taking the dog for a walk, getting in trouble at work*). Following

their analysis they reported that, relative to healthy controls, depressed individuals exhibited a greater tendency to produce the categorical form of general ABMs, whereas the two groups did not differ in terms of the number of extended memories they produced.

Another factor that has been shown to influence the specificity of depressed individuals' ABM retrieval is the valence of the retrieved memory. For example, Williams & Broadbent (1986) reported that depressed suicidal patients retrieved significantly more positive than negative overgeneral ABMs. This finding has been replicated in many subsequent studies (e.g. Brittlebank, Scott, Williams & Ferrier, 1993; Puffet et al, 1991; Williams & Dritschel, 1988). With this in mind, two recent studies (Park, Goodyer & Teasdale, 2002; Swales & Williams, 2001) are of note, as they reported no valence effects upon the specificity of retrieved ABMs. However, both of these studies addressed ABM retrieval in adolescents suffering from emotional disorders rather than adult patients, which might account for the different pattern of retrieval. It is clear, however, that in adult populations valence effects on specificity of ABM retrieval are relatively robust.

It should be noted that overgeneral ABM retrieval is not specific to MD and suicidal individuals, as it has also been observed in patients suffering from post-traumatic stress disorder (e.g. McNally, Litz, Prassas, Shin & Weathers, 1994; McNally, Lasko, Macklin & Pitman, 1995). There is also some evidence of overgeneral ABM retrieval in patients suffering from obsessive-compulsive disorder (e.g. Wilhelm, McNally, Baer & Florin, 1997). However, as noted by the authors themselves, it is possible that this finding related to co-morbid depression rather than their obsessive-compulsive

symptoms. It is also important to note that overgeneral ABM retrieval is not common to all psychological disorders, as there is little support for such a bias in anxious individuals (see Burke & Mathews, 1992; Richards & Whittaker, 1990) or patients with social phobia (Rapee, McCallum, Melville, Ravenscroft & Rodney, 1994).

Subsequent research has demonstrated that overgeneral ABM retrieval has important clinical and social consequences for individuals with depression. For example, Brittlebank et al (1993) reported that higher levels of overgeneral ABM retrieval, particularly of positive memories, were associated with poorer long-term outcome for clinically depressed patients. Furthermore, other studies (e.g. Evans, Williams, O'Loughlin & Howells, 1992; Goddard, Dritschel & Burton, 1996) have demonstrated that the generic retrieval style is associated with poorer interpersonal problem solving. Therefore, it is clear that the study of overgeneral autobiographical memory in individuals suffering from clinical depression represents an increasingly important avenue of research.

An account of overgeneral ABM retrieval in depression requires an understanding of the organisation of autobiographical knowledge in memory. There is considerable evidence (e.g. Conway & Rubin, 1993, Conway, Pleydell-Pearce & Whitecross, 2001) to suggest that autobiographical information is organised in some form of hierarchy, with information of increasing specificity at different levels of the hierarchy. Access to information at the higher (less specific) levels of the structure provides access to knowledge that is stored at lower (more specific) levels and vice - versa. It is proposed (e.g. Conway & Rubin, 1993) that the ABM knowledge base is accessed via a cyclical retrieval system, mediated by the central executive, that creates a general memory description based upon the available cues, searches memory using this description and then evaluates the output in terms of the task in hand. If the required

memory has been retrieved then the search is terminated with the current output. However, if the search does not produce the required specificity of knowledge then the cycle begins again and the memory description will be elaborated with information from related knowledge schema in order to predict further details of the target memory leading to its retrieval. Healthy individuals are able to move fluently through the hierarchy in order to access the specificity of information required by a given context. In contrast, as highlighted above, depressed individuals exhibit marked difficulties in moving from general descriptions to specific event memories.

Williams (1996) suggested that successful retrieval of specific autobiographical memories requires the inhibition of the intermediate categorical descriptions in order to allow contextual information (e.g. time and place etc) to be added to the memory search. In line with Conway & Rubin (1993), Williams also argued that this inhibition is a function of the central executive. Thus low central executive capacity would result in less specific memories. Evidence supporting this notion comes from a number of studies addressing retrieval of personal memories in patients that have reduced working memory capacity (e.g. brain injured patients; Baddeley & Wilson, 1986 or elderly adults; Winthorpe & Rabbitt, 1988), as they have reported that these individuals tend to produce overgeneral ABMs. However, in contrast to the pattern reported for depressed patients (Williams & Dritschel, 1992), these individuals tend to demonstrate increased retrieval of extended ABMs rather than categorical memories (Williams, 1996).

Williams and Dritschel (1988) suggested that individuals who are prone to emotional problems might use the overgeneral retrieval style in order to avoid the painful consequences of accessing specific negative memories. Williams (1996) suggested

that whenever a memory cue begins to access elements of an emotional event the search is strategically terminated by the individual in order to avoid the possibility of accessing a memory of a painful event. Williams argued that failure to access the required memory output would result in the cyclical retrieval mechanism initiating a second memory search. The result of the second search is another intermediate description that will again lead to a termination of the memory search once the process begins to access elements of previous emotional episodes. The consequence of subsequent iterations of the retrieval mechanism is, according to Williams, a chronically activated network of mainly negative general descriptions. Williams proposed that over time associations form between these general descriptions and also with novel event information. The consequence of this process is that, in future attempts to retrieve an ABM, the intermediate description that is accessed in response to the initial memory cue leads to the access of further general categorical descriptions, due to the strength of the associative links between the categorical memories. Williams (1996) termed this process 'Mnemonic Interlock', which he suggested was encouraged by, and encouraging of ruminative self-focus.

Evidence in support of the notion that overgeneral ABM retrieval might be a consequence of an attempt on the part of the depressed individual to avoid accessing negative event memories comes from a study conducted by Kuyken and Brewin (1995), who reported that depressed patients who had been subjected to childhood sexual abuse produced more overgeneral memories than did patients who reported no such abuse. Furthermore, patients who reported recent attempts to avoid thinking about memories concerning this abuse were also shown to retrieve a greater number of generic memories, relative to participants who did not report this tendency. However, as noted by Williams, Teasdale, Segal and Soulsby (2000), it is also

possible that the cognitive effort required to suppress these unpleasant memories reduces the amount of available cognitive resources, which would also contribute to the difficulty in moving from general to specific memories. In line with this notion, a number of studies have reported that a ruminative thinking style is associated with differences in ABM retrieval (e.g. Lyubomirsky, Caldwell & Nolen-Hoeksema, 1998; Watkins, Teasdale & Williams, 2000; Watkins & Teasdale, 2001). For example, Watkins et al (2000) reported that preventing rumination in depressed participants, using a distraction manipulation, reduced overgeneral ABM retrieval. A similar reduction in overgeneral ABM retrieval was observed in Watkins and Teasdale (2001) in conditions that led to reductions in analytical self-focus. They suggested that overgeneral ABM retrieval might be a consequence of rumination upon current or past problems, in an attempt to make sense of them.

Initially it was thought that overgeneral retrieval style was a trait phenomenon, i.e. was part of the make up of individuals who are prone to emotional problems. However, both of the studies conducted by Watkins and colleagues suggest that the categorical retrieval style is modifiable, as it was influenced by short-term cognitive manipulations. In line with this notion, a recent study (Williams, Teasdale, Segal & Soulsby, 2000) reported that a relatively new form of cognitive therapy 'Mindfulness' therapy was also successful in reducing the rate of overgeneral ABM retrieval. The key point here is that it appears to be possible to manipulate the specificity of ABM retrieval experimentally, which should provide greater understanding of the processes underlying overgeneral ABM retrieval.

1.4.1.2. Mood-congruent memory (MCM) bias for experimental materials in MD

Mood congruent memory has been defined as the tendency to recall information that is consistent with one's current mood (Watkins, Mathews, Williamson & Fuller, 1992). Using the verbal learning paradigm, a vast number of studies have demonstrated MCM bias for emotional stimuli in depressed individuals. For example, Derry and Kuiper (1981) presented depressed patients and healthy controls with a list of positive and negative self-referent words. At memory testing, they demonstrated that the depressed individuals exhibited superior recall of the negative words (e.g. *useless*), whereas the non-depressed participants demonstrated superior recall of the positive words (e.g. *excited*). This finding has been replicated on numerous occasions (e.g. Bradley & Mathews, 1983; Bradley *et al.* 1995; Denny & Hunt, 1992; Watkins *et al.* 1992; see also review by Blaney, 1986). It should be noted, however, that the MCM bias in MD appears to be confined to memory for self-referent, depression-relevant words (e.g. *failure*) and not all negative words (e.g. *cancer*).

MCM bias has also been demonstrated consistently in studies utilising recognition memory tasks. For example, Dunbar and Lishman (1984) conducted a study assessing the recognition memory of depressed individuals and healthy controls for previously viewed (positive, neutral & negative) affective words. They conducted a signal detection analysis and reported that although the depressed patients and controls did not differ in their memory for the neutral words the depressed individuals demonstrated superior memory for negative words. Conversely, the controls demonstrated enhanced memory for the positive words. Analysis of response biases indicated that depressed individuals exhibited preferential processing of the depression relevant words.

Superior recognition memory for depression-relevant words has been replicated on a number of subsequent occasions (e.g. Watkins et al, 1992). It should also be noted that despite the apparent robustness of the phenomenon there have been a small number of studies that have reported no recognition memory bias in depressed patients for depression-relevant, self-referent words (e.g. Baños, 2001). With this in mind, it is generally accepted that MCM bias in MD is stronger in recall than recognition tasks (see Dalgleish & Watts, 1990). Of particular note is an important meta-analysis of studies investigating mood congruent recall of positive and negative verbal material (e.g. words, sentences, whole texts) carried out by Matt, Vacquez and Campbell (1992). They revealed that clinically depressed individuals on average recalled 10% more negative than positive material. Conversely, healthy, non-depressed individuals were shown to demonstrate a bias towards superior recall of positive material (recalling an average of 8% more positive than negative).

Previous research addressing MCM bias in depressed individuals has focused almost exclusively on differences in memory for verbal material (words, stories etc). However, it is clear that biased memory for important social stimuli (e.g. emotional facial expressions) could have important consequences in terms of how depressed individuals view their social interactions. With this in mind, Ridout, Astell, Reid, Glen and O' Carroll (2003) conducted a study to establish if the MCM bias generalised to the processing of emotional facial expressions. In their study, 16 clinically depressed patients and 16 matched controls were presented with a series of photographic images of different individuals portraying happy, sad or neutral facial expressions. At encoding, participants were required to identify the valence of the emotion portrayed by the faces (i.e. *positive, neutral or negative*) and then were

subsequently given a recognition memory test for these faces. In line with studies addressing memory for affective verbal stimuli, depressed patients correctly recognised significantly more of the sad faces than either happy or neutral faces. In contrast, the healthy controls demonstrated superior memory for happy expressions relative to sad or neutral faces (these data are illustrated in figure 1.1). The findings of Ridout et al (2003) suggest that MCM bias is not confined to the processing of affectively valenced words, but notably is also present in depressed individuals' processing of socially relevant emotional stimuli. These findings will be discussed further in the section (1.5, page 36) concerning cognitive theories of major depression.

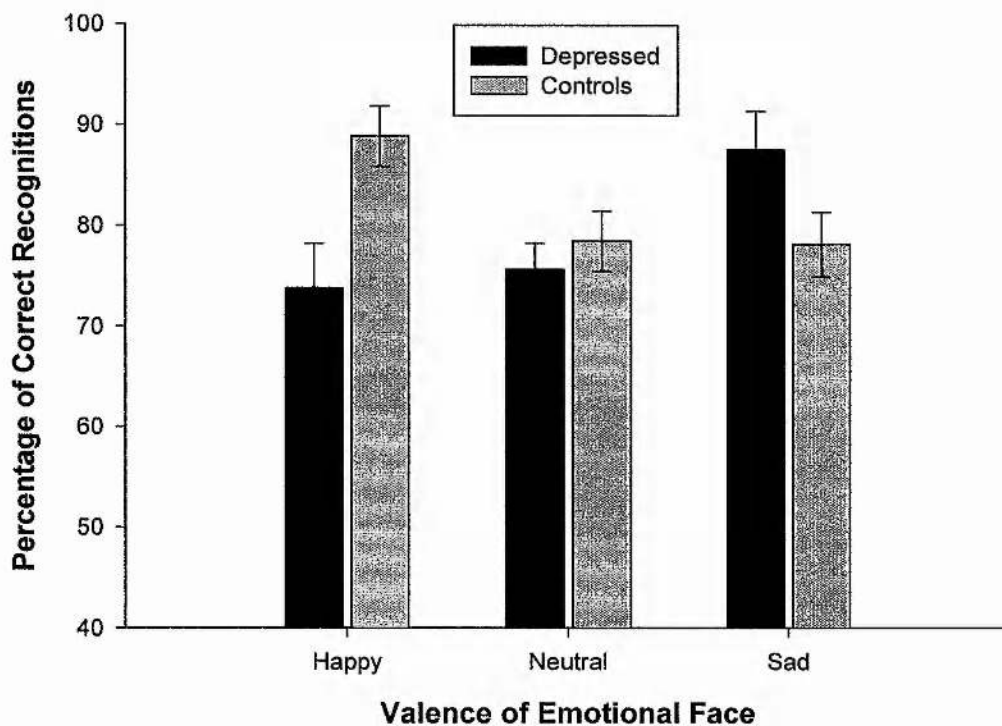


Figure 1.1. Percentage of each type of emotional faces correctly recognised by the participants during recognition memory testing (error bars show \pm one standard error of the mean) - reproduced from Ridout et al (2003).

The memory tasks that were utilised in the studies outlined above (e.g. recall & recognition) all assessed explicit memory function, i.e. these tasks require participants to actively search their memory for the previously learnt material. It should be noted that there have also been a number of studies that have addressed implicit memory function in depressed individuals (e.g. Watkins et al., 1996). Implicit memory refers to occasions where previously learnt material influences ongoing processing, but where the individual has not consciously searched for this information and may not even be aware that learning has taken place. The evidence that major depression is associated with a mood-congruent implicit memory bias has received considerably less support than the explicit MCM bias. The majority of studies have reported that depression is not associated with an implicit memory bias (e.g. Bazin et al., 1994; Denny & Hunt, 1992; Watkins et al., 1992). However, in a recent review, Watkins (2002) suggested that the failure to demonstrate mood-congruent implicit memory biases in MD might relate to the types of implicit memory tasks that have been utilised by the majority of previous studies. In general, previous studies have utilised tasks such as word fragment and word-stem completion. Such tasks rely on the priming of physical characteristics. However, Watkins (2002) successfully demonstrated the presence of an implicit memory bias in depressed individuals under circumstances that involved conceptual priming but not in tasks involving the priming of physical characteristics. Watkins (2002) suggested that implicit memory bias in depression might be confined to conditions that encourage conceptual priming. However, in a recent review of the literature concerning implicit memory function in major depression, Barry, Naus and Rehm (2004) reported that it is not the type of processing per se that is important for implicit memory bias in depression but rather whether there is a match between the type of processing required during the encoding task and the type of processing

required during the retrieval stage. This notion is referred to as Transfer Appropriate Processing (TAP). Originally proposed by Roediger and Blaxton (1987), the basic premise of TAP is that performance on a given task is dependent less on the type of memory system that is activated and more upon the match in processing requirements between the training and assessment phases. Thus participants' performance on a word-fragment completion task (a perceptual task) would be enhanced following a perceptual encoding task (e.g. categorise these words according to number of letters) relative to a conceptual encoding task (e.g. categorise these words according to their meaning), whereas participants would demonstrate superior performance on a conceptual retrieval task (e.g. sentence completion) when they had undergone conceptual training relative to perceptual encoding.

Barry et al (2004) proposed that the equivocal findings of implicit memory bias in depression could be accounted for within the TAP framework. In their review, they grouped the available evidence into two categories, the case for and against an implicit memory bias in depression. They demonstrated that studies providing evidence for such a bias in depression (e.g. Bradley et al, 1994, Ruiz-Caballero & Gonzalez, 1994, Watkins et al, 1996) had used a design that involved a match between the processing requirements of the encoding task and the retrieval task. Usually, these studies involved perceptual processing at both encoding and test phases. However, as reported above, implicit memory bias has also been demonstrated in tasks involving conceptual processing, but only in cases that have involved conceptual processing at both encoding and retrieval. In contrast, Barry et al (2004) demonstrated that studies that had failed to demonstrate an implicit bias in depression (e.g. Denny & Hunt, 1992, Ilsley et al, 1995; Watkins et al, 1992) had

designs that involved one type of processing during encoding (e.g. conceptual) and a different form of processing (e.g. perceptual) at retrieval. In conclusion, taking into consideration the recent evidence, it would appear that depression is associated with an implicit memory bias but only in situations where the learning and retrieval of the material involve the same form of processing. These findings will be discussed in more detail in section 1.5 (page 31), when the cognitive theories of depression are considered.

1.4.2. Selective attention for affective material in MD

In line with the studies addressing general attentional impairment (outlined in section 1.2.3, page 7) there have been relatively few studies investigating selective attention for affective stimuli in major depression, particularly in comparison to the vast number of studies that have been conducted into depressed individuals' memory for different types of emotional material. The evidence supporting the presence of biased attention for negative material has been equivocal. The remainder of this section will consider the evidence for and against the presence of a selective attention bias in major depression.

Selective attention for negative emotional material in MD has been demonstrated most consistently in studies that have utilised emotional analogues of the Stroop colour-naming task (see section 1.2.3. page 7 for a description of the traditional Stroop task and what is thought to measure). For example, Gotlib and Cane (1987) demonstrated that, relative to positive and neutral words, clinically depressed patients were significantly slower to colour-name depression-relevant words. This effect has subsequently been replicated on numerous occasions (e.g. Nunn, Mathews & Trower,

1997; Segal & Vella, 1990, Segal et al, 1995, and Williams & Nulty, 1986). It should be noted that a study conducted by Hill and Knowles (1991) failed to replicate this finding. Possible explanations for their findings could be the relatively small sample ($n=12$), the severity of depression in their sample (their patients were only mildly depressed) and finally the type of stimuli they utilised in their study (general negative words not strictly depression-relevant).

Despite the evidence of a MCM selective attention bias in depressed individuals provided by the studies using emotional Stroop tasks, the vast majority of studies utilising alternative measures of selective attention performance (e.g. the dot-probe task) have failed to provide further support for this phenomenon. For example, MacLeod, Mathews and Tata (1986) utilised the dot-probe task to investigate if depressed and anxious participants exhibited selective biases for negative stimuli. They reported that anxious individuals selectively attended to the threat words but the depressed individuals did not show this bias. A possible criticism of this study is that the words were threat-relevant and not depression-relevant and as noted above cognitive biases associated with emotional disorders usually require the stimuli to be condition relevant (see Williams et al, 1997). Therefore, in a related study, Gotlib, McLachlan and Katz (1988) incorporated depression-relevant words into the dot-probe task to address this criticism. However, they also failed to demonstrate evidence of a selective attention bias in the depressed individuals. Their results demonstrated that the depressed participants were even-handed in their attention to the different types of words, whereas the non-depressed individuals exhibited biased attention towards the manic words. A potential criticism of their study is that it was conducted using a student sample categorised as depressed or non-depressed according to their

scores on the Beck Depression Inventory and there is good evidence that clinical and 'analogue' samples differ in the type and strength of cognitive biases they exhibit (see Williams et al, 1997). Furthermore, it should be noted that Power & Dalgleish (1997) argued that the failure to demonstrate the positive attention bias that is associated with healthy mood, should also be interpreted as evidence of a negative bias on the part of the depressed patients.

Despite these findings it is important to note that there have been a number of studies that have utilised tasks other than the emotional Stroop and demonstrated evidence of privileged processing of depression-relevant stimuli in depressed patients. Bradley, Mogg and Lee (1997), for example, utilised the modified dot-probe task, to address selective attention to depression-relevant words in participants with induced and naturally occurring depressed mood. Importantly, they reported that both types of depressed mood were associated with an attention bias towards depression related words. However, these effects were only observed in conditions that allowed relatively prolonged processing of the words (around 1000 milliseconds). They reported that depressed mood was not associated with an early (pre-conscious) bias for negative words, as there was no bias present when the words were presented for short durations (14ms) and then masked.

The findings reported above for affective words have largely been replicated in subsequent studies using emotional facial expressions. Bradley et al (1997b) utilised the dot probe task to investigate dysphoric and non-dysphoric students attention to different facial expressions (angry, happy or neutral). They reported that dysphoric students demonstrated no attention biases in processing the facial stimuli, whereas the

non-dysphoric students attended away from the threatening (angry) faces. In a related study (Bradley et al, 1998), anxious individuals were shown to exhibit an attention bias towards angry faces, whereas participants who were high in dysphoria (indicated by high BDI scores) demonstrated a bias away from happy expressions. Similarly, Suslow, Junghanns and Arolt (2001) utilised an alternative measure of spatial attention (the face-in-the-crowd task) and reported that, relative to non-depressed participants, depressed individuals were significantly impaired at detecting happy expressions in an array of neutral expressions. However, these patients did not exhibit the increased sensitivity to detecting sad faces. Recently, Gotlib, Krasnoperova, Yue and Joormann (2004) utilised the dot-probe paradigm to investigate depressed individuals processing of emotional faces and replicated the findings of Bradley et al (1997a). Depressed individuals demonstrated biased selective attention towards the sad faces, but only in conditions that allowed prolonged processing of the stimuli (around 1000 milliseconds).

Taken together, these findings provide some evidence that depressed individuals selectively attend to depression-relevant material in their environment. However, it would appear that this bias does not operate in all areas of processing; most notably it does not appear that depressed individuals demonstrate biased pre-conscious attention to depression-related stimuli. The clearest interpretation of these findings, including the studies utilising the emotional Stroop task, is that depression is associated with problems in disengaging from depression-relevant material that has become the focus of attention, rather than enhanced spatial awareness of salient negative material in their environment. For example, if a depressed individual were giving a public speech they would not, relative to a healthy individual, be more sensitive to detecting a

person in the room that was yawning. However, if the depressed individual happened to notice the person yawning then they would tend to focus their attention on that person, whereas a person in a healthy mood would be more likely to focus their attention away from that yawning person towards someone who was paying attention, smiling and nodding for instance. In line with this notion, it would also seem that depression is associated with a loss of the positive bias that is characteristic of normal mood, a tendency that can also be interpreted as a negative attention bias (see Power & Dalgleish, 1997). These findings will be considered in more detail in the section (1.5, page 36) concerning cognitive theories of major depression. One thing that is clear is that further investigation of selective attention in depression, particularly in terms of the processing of socially relevant stimuli (e.g. emotional faces), represents an important and potentially fruitful avenue of study.

1.4.3. Emotion recognition and social perception in MD

Murphy et al (1999) presented depressed individuals and matched controls with a series of emotional words as part of an affective set-shifting task. They reported that the depressed patients were significantly faster to identify the emotional valence of depression-relevant words than positive words. This finding suggests that depressed individuals exhibit biased detection of depression-relevant material. In line with this notion there is some evidence that depressed patients demonstrate superior recognition of sadness from facial expressions (e.g. Mandal & Bhattacharya, 1985). Similarly, Murray & Perret (2000) reported that depressed individuals were more sensitive to the presence of sad mood in ambiguous facial expressions. Conversely, other studies have reported that depressed patients exhibit impaired recognition of emotion from faces (e.g. Feinberg, Rifkin, Schaffer & Walker, 1986). In line with this

notion, Persad & Polivy (1993) presented clinically depressed individuals with a booklet containing a series of emotional faces (half portrayed by a male, half by a female) and asked the participants to identify the emotion portrayed by choosing a one descriptor from seven possible responses (happiness, sadness, anger, disgust, surprise, anxious & indifferent). Persad and Polivy (1993) reported that depressed patients exhibited a general deficit in their ability to recognise emotion from photographic images of emotional facial expressions. Similarly, Bouhuys, Bloem & Groothuis (1995) reported a depression-related bias in the perception of emotional facial expressions, such that depressed individuals perceived more sadness in ambiguous expressions and less happiness in explicit facial expressions. These findings are consistent with the proposal that major depression is associated with deficits in social functioning (Cooley & Nowicki, 1989). However, it should be noted that other studies that have reported no differences between depressed participants and healthy controls in terms of emotion recognition from facial cues (e.g. Loeb, Feshbach, Beck & Wolfe, 1964). Furthermore, Ridout et al (2003) presented clinically depressed patients and healthy controls with photographic images of emotional faces via a computer screen and asked the participants to identify the emotion portrayed (happiness, sadness or neutral expression) by pressing one of three marked keys on the computer keyboard. The authors reported that depressed and non-depressed participants did not differ on the number of expressions they correctly recognised or on the types of recognition errors they made. The variability of these findings could relate to differences in the emotional stimuli utilised in the different studies or the type of task used to address emotion recognition during these studies. It is clear, however, that there is a need for further investigation of emotional processing from faces in major depression.

In addition to differences in emotion recognition (discussed above) there is evidence that depressed individuals are impaired on tasks that involve social perception. Social perception has been defined as the ability to read social cues and use them to make judgements about the behaviour, attitudes and emotions of others (McFall, 1982). For example, depressed individuals tend to provide negative interpretations when asked to judge stories concerning social situations that have an ambiguous meaning (e.g. Krantz & Hammen, 1979; Butler & Mathews, 1983). Furthermore, Bollenbach & Madigan (1982) presented undergraduate students that undergone a mood induction procedure (to induce either an elated or depressed mood) with drawings of social situations and reported that mood significantly influenced the participants' interpretations of the pictures, with depressed mood being associated with more negative perceptions. Similarly, Hoehn-Hyde, Schlottman & Rush (1982) presented clinically depressed individuals and healthy controls with videotapes of social interactions (either positive, neutral or negative in content). They reported that depressed individuals perceived the negative interactions as more negative than did the controls (but only when they were asked to imagine themselves involved in the social interactions). Hollander and Hokanson (1988) presented dysphoric and non-dysphoric students with videotaped scenarios involving a counselling session. Half of the clips portrayed the counsellor being genuine and in the other half the counsellor's behaviour was non-genuine. The dysphoric participants were unable to differentiate between the two types of behaviour. Overall the dysphoric students perceived less genuineness than did the controls. Further evidence that depression influences individuals' perception of social behaviour was provided in a recent study conducted by Ambady and Gray (2002). They presented dysphoric and non-dysphoric individuals (categorised according to their BDI scores) with 'thin slices' of non-verbal

behaviour (silent video clips of a teacher in a classroom lasting between 6 & 15 seconds) and asked them to make judgements of the competence of the individuals portrayed. Ambady and Gray (2002) reported that the dysphoric individuals provided less accurate judgements than did non-dysphoric participants. In a second study (also reported in Ambady and Gray, 2002) dysphoric and non-dysphoric participants were asked to make judgements about the type of relationships that existed between two individuals featured in another series of 'thin slices'. Again, the authors reported that dysphoria significantly impaired the accuracy of the participants' social judgements. Interestingly, participants' performance significantly improved when they were required to complete the social judgement task, whilst simultaneously performing a distracting task (that required cognitive resources).

It should be noted, however, that depressed individuals have also been shown to make more accurate social judgements than non-depressed individuals. For example, Edison and Adams (1992) asked dysphoric and non-dysphoric students to take part in dyadic social interactions. The participants subsequently rated their own and others social behaviour (the social interactions were also judged by independent raters). Dysphoric participants were more accurate in their perceptions of the quality of their own social performance than were non-dysphoric participants. Interestingly dysphoric individuals were also more accurate in judging other peoples social behaviour than were the non-dysphoric participants. Other studies have reported that depressed individuals do not differ from non-depressed individuals in terms of their social perception. For example, Price (1995) presented dysphoric and non-dysphoric participants with videotaped scenes of non-verbal behaviour (positive & negative in nature). She reported that there was no difference between the two groups in terms of their ability

to identify the valence of the behaviour. Despite these findings the weight of evidence suggests that depressed mood is associated with impaired social perception.

1.5. Cognitive theories of MD

During the last three decades there have been a number of theories proposed to account for the growing literature on the cognitive aspects of major depression. The next subsection of this chapter will provide an overview of two of the most influential of the early cognitive theories of depression, those of Beck's Schema theory (Beck, 1967) and Bower's network theory (Bower, 1981). The subsequent two subsections will outline two contemporary models of depression proposed by Williams, Watts, MacLeod and Mathews (1988; cited in Williams et al, 1997) and Teasdale and Barnard (1993).

1.5.1. Beck's Schema theory and Bower's network theory

According to the theory proposed by Beck (1967), depression relates to activity of dysfunctional schema. In terms of Beck's model (1967), schemas are stable representations of knowledge that have been acquired by an individual during their development. The knowledge stored in these schemas represents a person's beliefs, attitudes and assumptions, which are used to perceive, interpret and think about the events that an individual encounters day-to-day. Beck (1967) suggested that early life experience, particularly relating to loss in the case of depression, leads to the development of dysfunctional schemas. Activity of these dysfunctional schema leads to negative biases that colour the individuals' interpretation of the self, the world and the future, which in turn leads to, and maintains, the depressive episode. Bower (1981), in agreement with Beck, also argued that negative thinking and depressed

mood reinforce one another reciprocally. He developed an explanation of emotional disorders, including depression, based on his network theory (Bower, 1981). In his model, he proposed that emotions could be regarded as nodes in a semantic network with numerous connections to related ideas, physiological systems and events etc. He suggested that emotional material is stored in the network in the form of propositions or assertions. A thought occurs via activation of certain nodes by internal or external stimuli. Activation of a node, or set of nodes, leads to spreading activation throughout the network e.g. if the sadness node is activated then this can lead to the activation of depression-related nodes in the semantic network, such as hopelessness or despair (Eysenck & Keane, 1998). These two theories account well for the MCM bias demonstrated by depressed individuals for depression-relevant material (outlined in section 1.4.1.2, page 22). However, there are a number of findings that they cannot explain. For example, both would predict an implicit MCM bias in depression, which is not evident in the majority of studies addressing this phenomenon. Furthermore, both of these theories would predict a mood congruent attention bias in depression. Again, the available evidence does not support the presence of the type of wide-ranging mood-congruent attention bias that would be expected based on these models.

1.5.2. Williams, Watts, MacLeod & Mathews

Williams, Watts, MacLeod and Mathews (1988; 97) adapted Graf and Mandler's (1980) theory of cognitive processing in order to develop an alternative cognitive theory of depression. In line with Graf and Mandler (1980), Williams et al (1988; 97) proposed that there are two stages to cognitive processing: a "pre-attentive" integration (priming) stage and a subsequent elaboration phase. Priming is an automatic process that occurs rapidly without cognitive effort and involves the

activation of multiple elements associated with the representation of a particular stimulus. The result is a strengthening of the internal representation of this stimulus. This reinforcement of the representation makes the stimulus more 'accessible', i.e. it will be more likely to come to mind when only some of its components are present (e.g. initial letters in terms of words). By contrast, elaboration refers to a strategic process that involves associating new information with related material that is already represented in memory. This process involves the generation of new associative pathways, but also strengthens old pathways as a result of spreading activation between these related concepts. The result of this process is that elaborated material is more 'retrievable', than non-elaborated material, as it has a greater number of associative links with related in memory. Williams et al (1988; 97) argued that depressed individuals give priority to depression-relevant information during the strategic (under conscious control) elaboration phase, but that the pre-attentive (automatic) processes are largely unaffected in depression. Conversely, they argued that anxiety is associated with increased sensitivity to threatening information at the pre-attentive stage of processing, but that is not associated with changes in elaborative processing.

Williams et al's model (1988; 97) accounts well for the majority of experimental findings in the literature. For example, the model provides a good explanation of the robust explicit mood-congruent memory bias in depressed individuals (outlined above in section 1.4.1.2 (page 22)). According to the Williams model (1988; 97), at encoding depressed individuals strategically allocate more cognitive resources to the elaboration of depression-relevant material. As a result, more associative links are

formed between this material and other related material represented in memory, making this material more retrievable during subsequent memory testing.

As it is proposed in the Williams' model (1988; 97) that pre-attentive processing is relatively unaffected in depression then it would be expected that depressed individuals would not demonstrate changes in early attentional processing. Inspection of the review of selective attention in MD (section 1.4.2, page 28) reveals that the majority of the evidence is consistent with this proposal. Similarly, as implicit memory function involves priming (i.e. early, automatic, pre-attentive processing), according to the Williams' model, it would not be expected that depressed patients would demonstrate a bias in this memory function. In line with this proposal, the majority of available evidence has failed to demonstrate an implicit memory bias in depressed patients (see section 1.4.1.2, page 22).

Although, the model proposed by Williams et al. (1988; 97) clearly provides a good account of the majority of available evidence in the literature, there are a number of findings that represent problems for their model. For example, the findings of Watkins et al (1996) and Watkins (2002) demonstrating that depression-related implicit memory biases in circumstances that involve semantic priming. Furthermore, the findings of Power, Cameron and Dalgleish (1996) reporting emotional priming in depressed patients are also not consistent with the model proposed by Williams et al (1988; 97). A further problem encountered by the Williams et al (1988; 97) model is how to account for the difference between 'hot' and 'cold' cognitions. For example the fact that it is possible to retrieve an autobiographical memory and talk about it without experiencing the emotion that was associated with the event (termed 'cold'

cognition). However, it is also possible to retrieve the same ABM and to reinstate the emotion associated with the remembered event. Williams et al (1988; 97) suggested that multiple levels of representation are required to account for these two forms of processing. Teasdale and Barnard (1993) proposed an influential multi representational model that accounts well for the complex interaction between cognition and emotion, including the difference between 'hot' and 'cold' cognitions.

1.5.3. Teasdale and Barnard's *Interacting Cognitive Subsystems (ICS)* model

Teasdale and Barnard (1993) proposed that the cognitive architecture is divided into nine sub-systems. They suggested that each subsystem processes its own unique 'code' and has its own recording (memory) system. Therefore, the different elements of a given event are processed and represented in different subsystems. Three of these subsystems (*visual, acoustic & body state*) concern sensory and proprioceptive representations. Two subsystems (*morphonolexical & object*) represent intermediate structural descriptions and two systems (*propositional & implicational*) represent higher order meaning. Finally, two subsystems (*articulatory & limb*) relate to output systems. In terms of this model, emotion results only from processing in the implicational subsystem. The literal meaning of the statement "I failed my maths exam" can be represented in the propositional subsystem and such representation will not be accompanied by an emotional reaction, i.e. cold cognition. However, representation of the implicational meaning of this proposition, i.e. in terms of the schematic model of "me as a failure" will result in emotional reactions, i.e. hot cognition. Teasdale and Barnard's model can also provide an explanation of depressive cognition. According to Teasdale and Barnard (1993) depression is a consequence of generation of depressogenic schematic models in the implicational

subsystem and is maintained via a feedback loop with the propositional subsystem. In effect, the active schematic model generates propositions such as "I am useless" that feed back to the implicational subsystem reinforcing the active schematic model. The account given by Teasdale and Barnard for MCM bias is very similar to that proposed by Williams et al (1988; 97), i.e. depression-relevant material is more highly elaborated during encoding and at retrieval ongoing processing of depression-relevant schematic models will increase the likelihood that these representations are accessed. However, they propose that MCM bias will only be observed in conditions that enable representation of the material in the implicational subsystem, as the propositional subsystem may encode if a stimulus was considered good or bad but is only the implicational subsystem that can capture the affective properties of the stimulus.

1.6. Neural changes underlying mood and cognitive deficits in MD

There has been considerable discussion in the literature concerning whether major depression is associated with structural changes to the brain. There is some evidence, in elderly patients at least, that depression is related to changes in brain structure that are related to observed cognitive deficits (e.g. Abas et al, 1990). However, the majority of studies addressing the neural substrates of depressed mood and associated cognitive deficits have focused on changes in brain function rather than structure. One of the most consistent findings in studies using imaging techniques (e.g. PET, SPECT and fMRI) has been of abnormal blood flow in the pre-frontal cortex, in particular the dorsal and ventral anterior cingulate (e.g. Bench et al, 1992; Drevets et al, 1992; Drevets et al, 1997; Goodwin et al, 1993). Other studies have reported reduced blood flow in the orbitofrontal cortex in depressed individuals (e.g. Elliot et al, 1998). Furthermore similar changes in blood flow have been reported in the

striatum (e.g. Bench et al, 1992). These findings strongly suggest that functional changes, particularly in the region of the prefrontal cortex, are a feature of major depression. The perfusion of studies reporting prefrontal abnormalities supports the numerous findings of impaired executive 'function' in neuropsychological studies of depression (outlined in section 1.3, page 11). Of particular note are studies reporting abnormalities of function of the anterior cingulate (AC).

The AC is an area of the prefrontal cortex (PFC) implicated in a number of attentional processes that are central to normal performance on tasks such as the Stroop colour-naming task. For example, it has been suggested (e.g. Swick & Jovanovic, 2002) that the AC plays a role in the inhibition of pre-potent/pre-learnt responses (e.g. word reading). Furthermore, there is evidence (e.g. van Veen & Carter, 2002; Pardo, Pardo, Janer & Raichle, 1990) to support a role for the AC in the detection and resolution of conflict in cognitive processing. In line with this notion, impaired performance on the Stroop task has been related to prefrontal changes, particularly of the anterior cingulate (e.g. George et al, 1997). Furthermore, impaired AC function has also been related to impaired performance of depressed individuals on other 'executive' tasks. For example, Elliot et al (1997) reported that reduction in blood flow in the AC was related to impaired performance on the Towers of London task from CANTAB. These functional changes in the prefrontal cortex have also been implicated in the wide-ranging impairment of mnemonic function (outlined in section 1.2, page 3). For example, it has been suggested that the anterior cingulate probably plays a role in the control processes relating to memory (e.g. Fletcher et al, 1995). Furthermore, the AC region of the PFC has been implicated in recognition memory tasks (e.g. Elliot & Dolan, 1998). Drevets et al (1997) argued that the structural and functional changes in

the medial prefrontal cortex (including the dorsal and lateral anterior cingulate and medial orbitofrontal cortex) that have been observed in depressed individuals may be fundamental to this disorder, as these regions have been related to the relationship between cognition and emotion. Furthermore, these regions are modulated by the neurotransmitters implicated in depression (i.e. dopamine and serotonin). Also of relevance to the proposed course of study are the findings of reduced activation in the orbitofrontal cortex (Elliot et al, 1998) as disruption of this region has been implicated in impairment of recognition of emotion from faces and vocalisations (Hornak, Rolls & Wade, 1996).

1.7. Summary and Research Overview

From the preceding review it is clear that, in terms of processing neutral stimuli, major depression is associated with marked cognitive impairment, particularly in terms of mnemonic and 'executive' functions. Furthermore, there is considerable evidence that depression is associated with significant changes in the processing of emotional material. The most notable of these changes are associated with explicit retrieval of previously learnt depression-relevant material. Furthermore, it is clear that there are marked changes in ABM retrieval associated with MD. There is also some evidence that depression is associated with changes in selective attention, emotion recognition and social perception. However, these findings have not received the same degree of support as those relating to memory bias. As noted previously there have been a number of problems with these studies, most notably ensuring that the stimuli incorporated were depression-relevant.

Inspection of the relevant literature (outlined in section 1.4, page 16) reveals that the vast majority of studies addressing the processing of emotional material in major depression have focused on the processing of affective verbal material (e.g. words, stories etc). One exception to this trend was a study conducted by Ridout, Astell, Reid, Glen and O' Carroll (2003) that assessed depressed individuals memory for emotional facial expressions. The findings of this study demonstrated that the robust MCM bias that has consistently been demonstrated in patients with MD generalised to the processing of important, ecologically valid, social stimuli. The aim of this thesis is to continue the theme initiated in this study, i.e. to investigate the processing of non-verbal socially relevant stimuli (e.g. affective images or emotional facial expressions). Williams et al (1997) proposed that non-verbal emotional stimuli (e.g. pictorial images) might be more emotive than affective verbal material. If this assumption is correct then, in line with Teasdale and Barnard's ICS model (1993), it would be expected that a different pattern of processing would be observed for these stimuli, relative to verbal material. For example, Teasdale and Barnard (1993) argued that mood congruent biases would be stronger in conditions that encourage 'hot' processing, i.e. that encourages, representation of, and access to, the affective elements of the stimuli. Furthermore, it would seem clear that biased processing of important social stimuli could have serious consequences for the depressed individuals, particularly in terms of their social interactions with significant others.

This section of the chapter will take the form of an overview of the experimental studies that make up this thesis. In **Chapter three** a face-word variant of the emotional Stroop task was utilised in order to extend the literature concerning selective attention for emotional faces in major depression. Furthermore, this study

aimed to address if the to-be-ignored element of the stimuli (i.e. the faces) influenced subsequent memory of the to-be-responded-to element (i.e. the words). **Chapter four** investigated the influence of different cue modalities (pictorial or verbal) on retrieval of specific ABMs in MD. This aim of this study was to develop the work demonstrating that manipulating characteristics of the memory cue can modify specificity of ABM. **Chapter five** represents a replication of Ridout et al (2003) with one critical modification. The encoding task was changed (identify gender instead of identify emotion) in order to assess if the observed mood-congruent memory bias is dependent on explicit processing of the emotional valence of the faces. **Chapter six** involved presenting depressed individuals and matched controls with videotaped depictions of realistic social interactions in order to establish if, using dynamic ecologically valid stimuli, there is evidence to suggest that major depression is associated with deficits in emotion recognition and social perception. Finally, **Chapter seven** reports a related study that was conducted to establish if neurosurgical intervention for chronic, treatment refractory depression is associated with a deficit in emotion recognition and social perception.

- CHAPTER TWO -

COMMON MEASURES AND METHODOLOGIES

2.1. Introduction

The aim of this chapter is to give an overview of the procedures and assessments that were commonly used during the studies reported in the five experimental chapters. The subsequent sections of this chapter will cover how the depressed patients were diagnosed and how the severity of their depressive symptoms was established. Similarly, the procedures for assessing self-reported depression and anxiety in the patients and healthy controls will be outlined. Furthermore, a brief description of the method used to establish the level of the participants' general intellectual ability will be provided. Finally, the general assessment protocol for the participants that took part in the five experimental studies will be outlined, including an overview of the inclusion and exclusion criteria that were used during the recruitment of the patients and suitably matched controls.

2.2. Diagnosis of Major Depression

Previous research has demonstrated that many psychiatric conditions (e.g. anxiety, obsessive-compulsive disorder, post-traumatic stress disorder) in addition to major depression are associated with changes to normal cognitive function (see Williams et al, 1997). Likewise, it has also been demonstrated in previous research that different forms of depression may result in different patterns of cognitive impairment. In particular, differences between the depressive phase of bipolar disorder and major depressive episodes have been reported (Murphy et al, 1999). With this in mind, it was considered important in terms of the proposed studies to establish, using a

recognised method of classification/diagnosis, that the patients who took part in these studies were suffering from major, unipolar depression and not some other form of depressive disorder (e.g. bipolar) or different mental disorder (e.g. general anxiety disorder). This aim was achieved as part of the patients' initial assessment upon referral to the Affective Disorders Clinic at Ninewells Hospital in Dundee. On the first occasion that the patients attend the clinic they are interviewed (for around an hour) by a psychiatrist, using a semi-structured clinical interview schedule, and are subsequently assigned a diagnostic category, according to criteria laid out in the International Classification of Diseases (Version 10) Manual (ICD-10; World Health Organisation, 1993). The ICD-10 classification system has much in common with the American categorisation/diagnostic system the Diagnostic and Statistical Manual - version four (DSM-IV; APA, 1994). Both systems involve classifying disorders based on the profile of signs and symptoms that are established during the clinical interview (either reported by the patients during the interview, observed by the clinician or reported by significant others). The ICD-10 has been shown to have good inter-rater reliability in terms of consistent diagnosis of patients (WHO, 1993), which suggests that, although there is still some controversy concerning the validity of diagnostic systems such as DSM-IV and ICD-10, there can be a degree of confidence that the patients that took part in the five experimental studies were suffering from the same or highly related condition, namely unipolar depression.

2.3. Clinical Assessment of Depression Severity

2.3.1. The Hamilton Rating Scale for Depression (HRSD)

As previous research had demonstrated that the severity of a patients' depressive symptoms can exert a strong influence on their performance on a variety of cognitive

tasks, most notably some memory tasks (see review in section 1.3, page, 11), then it was considered important in the all of the experimental studies included in this thesis to quantify the severity of depression being experienced by the patients that took part. The Hamilton Rating Scale for Depression (HRSD; Hamilton, 1960) was chosen as the most suitable method of achieving this aim, as it is the most commonly used interviewer-rated measure of depression severity (Hammen, 1997) and would therefore allow comparison between the current studies and other previous investigations. The HRSD consists of 21 items concerning various aspects (biological, cognitive, psychological) of the participants' mood (by convention only 17 of these items are actually scored). The scale is completed during/following a clinical interview, which according to Hamilton (1960) should last around a minimum of 30 minutes. A recent development to the HRSD is the addition of descriptive anchor points to elicit greater objectivity in the scoring of the scale. Scores on the 17-item version of the HRSD range from 0 to 52. In terms of interpreting the HRSD scores, Katz, Shaw, Vallis and Kaiser (1995) reported that scores below six are generally considered to indicate healthy, non-depressed, mood. Furthermore, they suggested that scores between 7 and 17 on the HRSD are considered indicative of mild depression, ratings between 18 and 24 are generally considered to indicate moderate depression and scores of over 25 on the HRSD are taken to reflect severe depression. It should be noted that the HRSD was not designed as diagnostic tool, but rather was intended to provide an index of depression severity in patients that had already been diagnosed as suffering from clinical depression. Nevertheless, in terms of recruiting depressed patients for research studies a minimum severity rating is often stipulated. For example, a common cut-off that has been employed is a score of 14 or above on

the 17-item version of the HRSD (Katz et al, 1995). Although, it should be noted that other studies have reported the use of 17 as the cut-off point (see Katz et al, 1995).

A serious problem that has been identified in terms of the accurate scoring of the HRSD is the possible variation in the amount, and quality, of information collected by the different raters during the clinical interview. With this in mind, Williams (1988) developed the Structured Interview Guide for the HRSD (SIGH-D) in an attempt to minimise these potential differences by standardising the administration of the HRSD. Although previous research (e.g. Hedlund & Vieweg, 1979) had demonstrated good inter-rater reliability on the HRSD (around 0.84), Williams reported that use of the SIGH-D greatly improved the inter-rater reliability of the HRSD compared to the standard administration procedure.

Although, in most circumstances, trained clinicians (e.g. psychiatrist or clinical psychologist) are required to administer the HRSD, various studies (e.g. O' Hara & Rehm, 1983) have reported reasonable inter-rater reliability (0.76) between clinician ratings and those of lay individuals that have undergone training (around five hours) in the administration and scoring of the HRSD. The author (NR) underwent a short training course (10 hours) that initially involved observation of clinical interviews, where the clinician would 'talk-through' with NR the Hamilton rating they had given for each patient. In later training sessions NR also provided HRSD ratings for the patients and these were discussed and compared with those provided by the clinician. As part of this training, NR rated the severity of depressive symptoms exhibited by a group of six psychiatric outpatients. NR interviewed the patients using Williams (1988) structured interview schedule for the HRSD. These patients had also been

assessed (within a week of NR's rating) on the HRSD by one of the psychiatrists at the ADC. The ratings provided by the author were compared statistically with those provided by the clinicians using a Pearson's correlation test and an independent t-test. There was a significant, positive correlation between the ratings produced by the author and the clinicians; $r(6)=0.99$, $p<0.001$. Furthermore, there was no significant difference between the HRSD ratings provided by the author ($\mu=14.7$, $SE=5.1$) and the clinicians ($\mu=15.8$, $SE=5.5$); $t(10)=0.2$, $p>0.05$. These findings strongly suggest that the HRSD ratings provided by the author can be considered reliable in comparison to those provided by the clinicians at the ADC.

2.4. Self-report Measures of Mood

2.4.1. *The Beck Depression Inventory (BDI)*

In line with the aim of quantifying the severity of depression experienced by the patients in the current studies, it was also considered important to obtain a measure of self-reported depression severity. Furthermore, it was considered important to screen for the presence of depressive symptoms in the participants making up the control groups, as the presence of depression in the controls could mask group differences. The Beck Depression Inventory (BDI; Beck et al, 1961) was considered the most suitable measure to achieve these aims, as it is the most frequently utilised self-report measure of depression (Hammen, 1997). In addition to its wide use amongst clinicians, the BDI has been commonly employed to establish self-reported depression severity in experimental studies investigating the affect of depressive symptoms on cognitive performance, and to screen for depression in controls. Furthermore, a review of a number of studies reported in Katz et al (1995) demonstrated that the BDI correlates strongly with most other self-report measures of

depression. More importantly, previous studies have demonstrated that the BDI correlates particularly strongly (0.96) with clinicians' ratings of depression severity (Beck, Rial & Rickels, 1974).

The BDI is presented to the participants in questionnaire format, and consists of 21 items that are designed to assess the emotional, cognitive, behavioural and biological aspects of the patients' depressive symptoms. Each item on the BDI consists of four statements that are graded in terms of the severity of depression they represent, with the least depression-relevant response (e.g. *I do not feel sad*) being scored zero and the most depression-relevant statement (e.g. *I am so sad and unhappy that I can't stand it*) being scored with a three. For each of the 21 items the participants are required to circle the number associated with the statement that best represents their mood during the week prior to assessment. The sum of the scores represents the severity of the participants' depression, with a range of 0 to 63. In terms of interpreting participants' BDI scores, Beck, Steer and Garbin (1988) reported that it is generally accepted that a score of less than 10 is indicative of normal, non-depressed, mood; a score of 10 to 18 suggests that the individual is experiencing mild depressive symptoms; scores ranging between 19 and 29 reflect moderate depression and scores of 30 plus are taken to indicate the presence of severe depressive symptoms. However, it is important to note that the BDI was not designed as a diagnostic tool but rather was intended to represent a continuous dimension of depressive symptoms that cuts across a variety of diagnostic categories. With this in mind, Katz et al (1995) proposed that the BDI could be better conceived of as a measure of general psychological distress. Despite this proposition, the BDI was considered to be the most suitable self-report measure of depression severity for the proposed studies,

mainly due to the strong correlations between BDI scores and other self-report measures of depression, and most notably clinicians' ratings of depression severity.

2.4.2. The Hospital Anxiety and Depression Scale (HADS)

There is strong evidence (see Williams et al, 1997) that anxiety is also associated with marked changes in cognitive function. It is clear that the presence of co-morbid anxiety could confound any observed effects of depression on the various tasks employed during the course of the experimental studies. It was therefore considered extremely important to ascertain the level of co-morbid anxiety in the patients, and also to screen for anxiety symptoms in the healthy participants, in order to control for the effects of anxiety on task performance. The Hospital Anxiety and Depression Scale (HADS; Zigmond & Snaith, 1983) is a short self-report measure of anxiety and depression severity, which consists of fourteen items (7 referring to depressive symptoms & 7 referring to anxiety symptoms). Each item features a single statement presented in bold (e.g. **I feel tense or 'wound up'**) followed by four possible responses (e.g. 'most of the time', 'a lot of the time', 'from time to time', 'occasionally' & 'not at all') and the participants are required to indicate which of the responses best represents their mood during the week prior to the test session. Previous research (Zigmond & Snaith, 1983) has demonstrated a high correlation between the participants' scores on the anxiety sub-scale of HADS and clinicians' ratings of anxiety severity (0.74). Likewise, a strong relationship between participants' scores on the depression subscale and clinicians' ratings of depression severity has also been reported (0.7). These findings, coupled with the brevity of its administration, suggested that the HADS was highly suitable for use in the proposed studies. A further advantage of the HADS over other self-report measures of anxiety

(e.g. the Spielberger State Trait Anxiety Inventory) was that it provided a further self-report measure of depression severity.

2.5. Estimation of Pre-morbid Intellectual Ability

When conducting investigations into the performance of clinically depressed patients on tasks that involve cognitive processes it is important to quantify, and control for, the participants' general intellectual ability, as differences between the groups in pre-morbid intelligence could potentially confound findings of group differences on the various tasks. As it was not feasible (or desirable) to assess the participants intelligence using a full IQ test, a relatively quick method was required that would provide an accurate estimate of general intellectual ability. Furthermore, as clinical depression has been shown to impair performance on many cognitive tasks (see Murphy, Sahakian & O'Carroll, 1998) it was important that the method used was resistant to the effects of depression on cognition. It has been reported in previous studies (e.g. Crawford et al, 1987) that the National Adult Reading Test (NART, Nelson, 1982) provides an accurate estimate of depressed individuals' general intellectual ability that is unaffected by their depressive symptoms. The NART involves presenting participants with a series of 50, relatively short, English words (increasing in difficulty from the beginning of the list to the end). The participants are required to read aloud how they think each word should be pronounced. The words used on the NART were chosen specifically because they have an irregular pronunciation; that is the correct pronunciation cannot be established by phonemic decoding but rather relies on word recognition. As, in the normal population, the number of reading errors on the NART is highly correlated with WAIS IQ score it is

possible to predict participants' full-scale IQ score just from the number of errors they make on the NART (Nelson & Williamson, 1991).

2.6. General Assessment of Patients and Controls

2.6.1. General Assessment of Patients

All of the patients that took part in the five studies reported in the experimental chapters were recruited from the Affective Disorders Clinic (ADC) at Ninewells Hospital in Dundee. Prior to taking part, a psychiatrist at the ADC assessed the patients' clinical status according to ICD-10 diagnostic criteria (following a semi-structured clinical interview). Within a week prior to the test session, the severity of the patients' depression was assessed using the 17-item HRSD. This assessment was conducted either by one of the psychiatrists at the ADC or in later studies by the author (using Williams SIGH-D). On the day of testing, the patients' self-rated depression and anxiety was assessed using the 21-item BDI and the HADS. Finally, an estimate of the patients' general intellectual ability was obtained using the NART.

2.6.2. General Assessment of Healthy Participants

The healthy participants were recruited from a variety of sources using recruitment posters and word of mouth. The backgrounds of the participants making up the control groups were varied, including non-academic staff at the universities of St Andrews, Dundee, and Abertay, undergraduate students at the Open University and the evening degree course at St. Andrews, shop workers, clerical staff, cleaners, goods drivers, postgraduate students at Dundee university, and chefs. A number of the controls were unemployed and a number were retired. Prior to inclusion in the five experimental studies, potentially suitable controls were screened using a simple

questionnaire (see Appendix I) to ensure that they met the inclusion criteria and did not meet any of the exclusion criteria (see below). On the day of testing, the controls were asked to rate their recent mood (over the week prior to the test session) using the 21-item BDI and the HADS. On the day of testing, they were also required to complete the NART in order to allow an estimate of their general intellectual ability to be obtained.

2.6.3. Inclusion and exclusion criteria for the clinical studies

The participants who were included in the “depressed” groups of the five experimental studies were required to meet the following criteria. An ICD-10 diagnosis of major depression without bipolar or psychotic symptoms, plus a depression severity score of 14 or above on the 17-item Hamilton Rating Scale for Depression (Hamilton, 1960). Furthermore, the patients were required to be aged between 18 and 65 years of age. Exclusion criteria for the depressed sample included failure to meet the inclusion criteria, recent ECT treatment (within six months of the test session), suspected chronic alcohol and/or substance abuse, suspected neurological disorder (e.g. Korsakoff’s), history of head injury that resulted in prolonged loss of consciousness and that required hospital treatment, and/or the presence of a physical disorder or pharmacological treatment, that might be considered likely to impair cognitive function (e.g. Multiple Sclerosis). Inclusion criteria for the healthy controls in the clinical studies of this thesis included meeting the required matching characteristics to the depressed participants; i.e. age (± 3 years), sex and educational background (± 2 years), no current or prior diagnosis of major depression, aged between 18 and 65 years of age and a BDI score of less than 10 on the day of testing. The exclusion criteria for the controls were identical to those for the patient sample.

2.7. Data Analysis

Parametric test assumptions were established for each study using the following protocol. To confirm that the data was normally distributed, the mean and median of each cell was compared to confirm that they were similar. The mean and standard deviation of each cell were compared to confirm that the standard deviations were not bigger than the mean. The histograms of the distribution of scores in each cell were examined to see if they approximated a bell shaped curve. The normality plots were examined to establish if the observed data points lay close to the predicted distribution. Finally, Kolomogorov & Smirnov and Shapiro & Wilks normality tests were conducted to establish if the observed data differed significantly from the predicted distribution. The evidence from all of these sources was weighed in order to confirm if the data was or approximated a normal distribution. The data from each study was examined to confirm homogeneity of variance by comparing the standard deviations of the different cells to confirm that the larger was not vastly different from the smaller (it is generally excepted that homogeneity is met provided the larger SD is not vastly greater than double the smaller). As all studies made use of repeated measures ANOVA sphericity assumptions were also tested. Where these assumptions were not met the results from more conservative tests were used (e.g. Greenhouse-Geisser).

2.8. Summary and Conclusions

The recruitment and assessment procedures outlined in this chapter ensured that although the different participant groups (depressed & controls) of the five experimental studies represented distinct groups in terms of their clinical status and

COMMON MEASURES AND METHODOLOGIES

mood, they were well matched on important variables (age, sex, educational background, & general intellectual ability).

- CHAPTER THREE -

SELECTIVE ATTENTION AND RECOGNITION MEMORY FOR AFFECTIVE WORDS IN MAJOR DEPRESSION: *THE INFLUENCE OF DISTRACTING EMOTIONAL FACIAL EXPRESSIONS*

3.1. Introduction

Evidence for a selective attention bias for depression-relevant material in major depression has been equivocal. However, as reported in chapter one (section 1.4.2, page 28) there is at least some evidence, particularly from studies utilising emotional versions of the Stroop colour-naming task, that depressed individuals selectively attend to salient emotional material in their environment. Nevertheless, it would appear that this bias does not operate in all areas of processing; most notably it would appear that depressed individuals do not demonstrate biased pre-conscious attention to depression-related stimuli. The clearest interpretation of the available findings is that depression is associated with problems in disengaging from depression-relevant material that has become the focus of attention, rather than enhanced spatial awareness of salient negative material in their environment. It should also be noted that a number of studies (see section 1.4.2, page 28) have reported that depressed individuals fail to demonstrate the positive attention bias that is associated with healthy mood, and some researchers (e.g. Power & Dalgleish, 1997) have argued that this should also be interpreted as evidence of a negative attention bias.

One criticism that can be levelled at a number of the studies that have failed to demonstrate biased attention in depressed patients (e.g. MacLeod, Mathews & Tata,

1986) is that they have utilised stimuli that are not strictly depression-relevant. This is important; as there is good evidence that the biased processing associated with emotional disorders is restricted to material that is condition-relevant (see Williams et al., 1997). Power and Dalgleish (1997) also noted this point and suggested that there was a need for studies addressing depressed individuals' attention for emotional stimuli with high personal relevance, such as emotional facial expressions.

Emotional facial expressions are an extremely important class of social stimuli that enable human beings to ascertain extremely quickly the mood, and possible intentions of other individuals. Biased processing of these stimuli could have serious consequences for depressed individuals, particularly in terms of social interactions with significant others. In line with this notion, Persad and Polivy (1993) proposed that changes in the processing of facial expressions by depressed individuals might underlie the difficulties that they experience in conducting social interactions. Some support for this notion comes from a study conducted by Ridout, Astell, Reid, Glen & O' Carroll (2003), who demonstrated that clinical depression is associated with superior memory for sad faces relative to happy and neutral expressions (see figure 1.1, page 25). The authors considered that such a bias was likely to colour the patients' interpretations of social interactions they were involved in. From the above, it is clear that investigation of possible attention biases for emotional facial expressions in major depression is an important avenue of research that could have significant implications for the current understanding of depression. The next section of this chapter will consider briefly the evidence concerning selective attention bias for emotional faces in major depression.

3.1.1. Selective attention for emotional faces in major depression

Whilst there is considerable evidence (e.g. Fox, Russo & Dutton, 2002; Bradley et al., 1998; Bradley et al., 1997) demonstrating the tendency of anxious individuals to selectively attend to threatening (angry) facial expressions, even when they are presented subliminally, the existence of such a bias for sad faces in depression has not received the same degree of support (see section 1.4.2, page 28). However, the studies that have been conducted to assess depressed individuals' attention for faces can be criticised on a number of grounds. First, they have tended to use threat-relevant (angry) expressions rather than depression-relevant (sad) faces. Furthermore, studies that have used sad faces have tended to use schematic drawings of emotional expressions rather than photographic images, which may have reduced the impact of these stimuli. From the literature utilising verbal stimuli (e.g. words) it would be expected that depressed individuals might exhibit problems in disengaging their attention from sad faces under conditions that allowed relatively long (around 1000 milliseconds) processing of the stimuli.

As noted above, a tendency to focus attention on sad facial expressions could influence the patients' interpretation of social interactions they are involved in. However, it is clear that successful comprehension of social interactions actually requires processing of multiple "channels" of information simultaneously (e.g. the words that are spoken by the conversational partner, their facial expression, body posture, tone of voice etc.) rather than individual sources of stimuli. It is also clear that these different "channels" might on occasion be sending conflicting information, thus individuals have to interpret all available social information in order to establish the meaning of the interaction. The question that arises is, "*under circumstances that*

involve the presence of a number of types of stimuli, do depressed individuals focus their attention on depression-relevant stimuli?" Previous research (e.g. Gotlib & Cane, 1987) using the emotional Stroop task would seem to suggest that they would. However, this question has not been addressed using emotional faces. This is important, as it could be argued that a study utilising emotional faces would have greater ecological validity in terms of understanding the possible impact of biased attention on patients' social functioning. With this in mind, one aim of the current study was to address this question using photographic images of emotional facial expressions.

A potentially useful paradigm in terms of the proposed study was utilised in a series of studies conducted by Stenberg, Wiking and Dahl (1998). The authors were interested in establishing the extent to which certain characteristics of facial expressions (most notably the emotional valence) were processed automatically, and furthermore, the influence that this automatic processing exerted on other concurrent processing. They presented healthy participants with a series of compound stimuli consisting of affective words, half positively valenced (e.g. *joyful*) and half negatively valenced (e.g. *useless*), superimposed across photographs of happy, sad and neutral emotional facial expressions. The participants were instructed to disregard the faces and to identify the emotional valence of the words. Stenberg and colleagues (1998) reported that the valence of the faces interfered with the identification of incongruent words but enhanced the identification of congruent words.

The current investigation employed this face-word variant of the Stroop task in order to address the question reported above. Stenberg et al (1998) did not assess the effect of depressed mood on this task, but, based on the findings of previous studies

demonstrating impaired inhibition of distracting “off-task” stimuli (e.g. MacQueen et al., 2000), it would be expected that the depressed patients would be more likely, than healthy individuals, to process the to-be-ignored element of the stimuli (i.e. the faces). Furthermore, from research reported above, it would be expected that the depressed patients would exhibit problems in disengaging their attention from sad faces that entered the focus of their attention, which in turn would disrupt concurrent processing of the superimposed words. However, in a previous study, Murphy et al (1999) demonstrated that depressed individuals were significantly faster to identify the valence of negative words relative to positive, suggesting an identification advantage for depression-relevant material. With this in mind, it might be expected that conditions involving depression-relevant words superimposed on sad faces would enhance this identification advantage in the depressed patients.

Another important question that arises from this work is *“how does processing of the to-be-ignored element of the stimuli (i.e. the faces) influence subsequent memory for the to-be-responded-to component of the stimuli (i.e. the words)?”* The following section of this chapter will briefly consider the evidence concerning MCM bias in depression and how the presence of other affective material is likely to affect depressed individuals’ memory for the different words.

3.1.2. Recognition memory for affective material in major depression

As reported in chapter one (section 1.4.1.1, page 17), mood-congruent memory (MCM) bias for self-referent depression-relevant words is an extremely robust finding in depressed patients. Furthermore, depressed patients have also been shown to exhibit similar preferential memory for sad faces (Ridout et al., 2003). However,

previous studies investigating MCM bias in depression have presented the “to-be-remembered” stimuli (*e.g. emotional words, sentences, & emotional facial expressions*) in isolation i.e. the participants were required to attend to only one set of stimuli during the experiment. However, it can be argued that in an individuals’ everyday life any number of emotional and non-emotional stimuli may appear simultaneously in the individuals’ environment. It would seem feasible that these combinations of stimuli might influence which elements of an individual’s environment are remembered. In line with this notion, Stenberg and colleagues (1998) reported that their participants demonstrated enhanced memory for words that were presented at encoding with incongruent faces (particularly positive words paired with sad faces). They explained these findings in terms of elaboration, suggesting that due to the unusual nature of the incongruent pairings the participants allocated more resources to processing of these combinations. In terms of depressed patients, from Williams et al. (1997) it would be expected that negative word/sad face pairs would receive greater elaboration by the patients than would all other face/word pairs, leading to enhanced recognition memory of negative words that were paired with sad faces at encoding.

A further area of interest that the current study hopes to address is the extent to which depressed individuals might be susceptible to the creation of false memories, particularly in terms of negative memories. The subsequent section will consider how this can be addressed in the current study.

3.1.3. Investigating false memories in major depression

False memories can be conceived of as either remembering events that never occurred, or remembering events as markedly different from how they actually were (Roediger & McDermott, 1995). Due to the nature of depressed individuals' processing (e.g. the tendency to interpret ambiguous situations in a negative light) it would seem plausible that these individuals might be predisposed towards the second kind of false memory, i.e. remembering events as more negative than they actually were. The list-learning paradigm utilised by Roediger and McDermott (1995) was incorporated into the current study in order to address this notion. Roediger and McDermott (1995) presented participants with multiple lists of words to learn. Each list consisted of associates of a non-presented word, referred to as the critical "lure". In their study they demonstrated high levels of false recognition of these non-presented "lure" words. As it has been suggested (e.g. Segal et al., 1995) that depression-relevant concepts are highly interconnected in the cognitive systems of depressed individuals it would be expected that activation of some of these depression-relevant concepts (at encoding) would lead to the activation of other related concepts. Having been activated during encoding these units would be more likely to be reactivated during retrieval. This notion suggests that depressed patients would be more susceptible to the false recognition of non-presented depression-relevant words, than would the controls.

3.1.4. Overview and Predictions

Clinically depressed patients and healthy matched controls were presented with a series of compound stimuli (each consisting of an affective word superimposed across a photograph of an emotional facial expression). The participants were required to

ignore the faces and to identify the emotional valence of the words, as quickly and accurately as they could. After a filled delay, they were given a recognition memory test for the words they had viewed during the selective attention task. Within the sets of non-presented distracters (positive & negative words only) there were a number of critical lures (words that are strongly related to the previously viewed material). The following predictions were made:

3.1.4.1. Hypotheses tested during the selective attention phase:

1. Based on the findings of Stenberg et al (1998) it was expected that, overall, participants would be significantly slower to identify the valence of the words paired with incongruent faces than those paired with congruent or non-congruent (neutral) expressions.
2. In line with the findings of Stenberg et al (1998) it was expected that the controls would demonstrate a positive word identification advantage (evidenced by faster identification times) that would be enhanced when the words were paired with happy faces and abolished when the words were presented with sad facial expressions. Conversely, based on Murphy et al (1999) it was expected that depressed patients would demonstrate a negative word identification advantage that would be enhanced when the words were presented with sad faces and abolished when the words were paired with happy expressions.
3. In line with Stenberg et al (1998) it was predicted that, overall, participants would make significantly more valence identification errors when the words were paired with incongruent facial expressions than when they were presented with congruent or non-congruent faces.

4. In line with Stenberg et al (1998) it was predicted that controls would be more accurate when responding to positive words than neutral or negative. Conversely, it was expected that depressed individuals would be more accurate when responding to negative words than neutral or positive.
5. In line with previous studies (e.g. Gotlib & Cane, 1987) it was predicted that depressed individuals would be significantly slower to identify the valence of the neutral words when they were paired with sad faces than when they were presented with happy or neutral expressions. However, it was not expected that the neutral word identification times for the controls would differ as a function of the type of facial expressions these words were presented with.

3.1.4.2. Hypotheses tested during the recognition memory phase:

6. Based on previous studies (e.g. Bradley et al, 1995, Watkins et al, 1992) it was expected that depressed individuals would correctly recognise significantly more negative than neutral or positive words. However, it was also predicted that the depressed patients would recognise significantly more of the negative words that were paired with sad faces than those that were paired with happy or neutral expressions.
7. Finally, it was predicted that the depression-relevant lures would be falsely recognised by significantly more of the depressed patients than the controls.

3.2. Method

3.2.1. Design

This study made use of a 2 between (*group*) x 3 within (*face valence*) x 3 within (*word valence*) mixed factorial design. The independent variables for both the

selective attention and recognition memory phases of the study were the valence of the emotional facial expression on which the words were superimposed (*happy, sad or neutral*) and the valence of the words (*positive, negative or neutral*). The dependent variables during the selective attention phase were the time taken (in milliseconds) to identify the emotional valence of the words, and the percentage of valence identification errors. The dependent variable during the recognition memory phase was the percentage of words correctly recognised from the selective attention task. The independent variable for the false memory analysis was the valence of the non-presented "lures" (*positive or negative*). The dependent variable was the number of participants from each group (*depressed & controls*) that falsely recognised the critical 'lures'.

3.2.2. Participants

Thirty-two clinically depressed patients (19 females, 13 males) and thirty-two healthy controls (19 females, 13 males) took part in the current study. According to Cohen (1992) this sample size is suitable to detect the medium to large effect sizes that were predicted from previous studies (e.g. Gotlib & Cane, 1987; Stenberg et al, 1997) addressing selective attention (see appendix II for full details of the power analysis). The two groups in the current study were matched in terms of age, sex, educational background and general intellectual ability (see table 3.1, page 76). The participants (*depressed & controls*) were recruited according to the inclusion and exclusion criteria cited in chapter two (section 2.6.3, page 55). Furthermore, upon admission to the study they were assessed according to the standard protocol outlined in chapter two (section 2.6.2, page 54). The characteristics of the individuals making up the two participant groups are reported in table 3.1 (page 76). As outlined in chapter two

(section 2.3.1, page 48), the severity of the patients' depressive symptoms was assessed using the Hamilton Rating Scale for Depression (HRSD). The mean HRSD score for the patients in the current study was 20 (with a range of 14-28), indicating moderate to severe depression.

3.2.3. Materials and Apparatus

3.2.3.1. Emotional Facial Expressions (distracters)

Two sets of twelve grey-scale photographic images of different individuals portraying emotional facial expressions were used to provide the distracting element of the compound stimuli that were presented to the participants during the selective attention task. In each set of twelve, four images featured individuals portraying happiness, four showed a sad expression and in the remaining four images the individuals portrayed a neutral expression. The individuals that portrayed happiness in set A were posed in a sad expression in set B and vice versa. Different individuals (matched for their sex and approximate age) portrayed the neutral expressions in the two sets. The age and sex of the individuals portraying the facial expressions were matched across the different emotional expressions, as it was considered that these variables might influence the distractibility of an image. The rationale for creating two sets of images also concerns factors other than emotional expression that might influence the distractibility of the images and is outlined fully in section 3.2.3.3 (page 70). The photographic images used in this experiment were drawn from a set used in a study looking at emotion perception in healthy adults (Le Gal & Bruce, 1999). In creating their set of images Le Gal and Bruce presented the faces to seventy undergraduate students (35 male, 35 female) one at a time in a random order and asked the students to make a forced choice decision concerning the emotion portrayed (*happiness,*

sadness, surprise, anger, disgust, fear and neutral expression). The faces included in the current study all received over 75% subjective agreement concerning the emotion portrayed. A further six neutral faces were used to make up practice and buffer stimuli (outlined below).

3.2.3.2. Affective Words

72 affective words (24 positively valenced; e.g. *successful*, 24 negatively valenced/depression-relevant; e.g. *guilty* and 24 of neutral valence; e.g. *medium*) were drawn from a larger set of words compiled by the author during a pilot study. In that study, one hundred and sixty words (40 negatively valenced, 40 positively valenced and 80 considered to be neutral in valence) were presented to one hundred undergraduate students (50 males & 50 females) who were asked to rate the words in terms of their emotional meaning (*positive, neutral or negative*) and emotional strength (emotionality) on a 7-point scale (*where 1 = not emotional and 7 = extremely emotional*). The 24 words in each category (*positive, negative & neutral*) that achieved the highest rate of subjective agreement in terms of their emotional meaning were chosen as the stimuli for the current study. All of the words included in the current study achieved over 95% subjective agreement concerning their emotional meaning. The subsets of words (*positive, neutral & negative*) were matched for length (*number of letters*) and frequency (*rate per million words*) according to Francis and Kuçera, 1982. The positive and negative words were also matched for their emotionality, but as expected both sets were rated as significantly more emotional than the neutral words. Two sets of thirty-six words (each consisting of 12 positively valenced, 12 negatively valenced and 12 neutral valence words) were created from the set of 72 words that were chosen from the corpus rated by the students. The two sets

of words were matched on all relevant variables (*word length, frequency, percentage agreement over their emotional meaning, and their emotional strength*). One set of the words (see appendix III) was combined with the emotional faces (outlined in section 3.2.3.1, page 61) to form the compound stimuli that were presented to the participants during the selective attention task. The other 36 words (see appendix IV) were used as distracters (i.e. the novel words) during recognition memory testing. Full details of the analysis conducted to ensure the two word sets did not differ significantly on important characteristics (e.g. frequency, emotionality etc.) can be found in appendix IV. Within each set of distracters (*positive & negative words only*) were two words considered (by the author) to be most indicative of the nature of the particular class of words. The negative lures were "*depressed*" and "*sad*" and the positive lures were "*excited*" and "*charming*". A further ten words (3 positive, 3 negative & 4 neutral) were included to make up the practice and buffer items (outlined below).

3.2.3.3. Compound Stimuli

The two sets of twelve emotional facial expressions were each combined with the thirty-six affective words. Each image was paired with three different affective words (*one positive, one negative and one neutral*). The words were printed across the photographs in bold 24-point text. The words had to be positioned in such a way that the eyes and mouth were not obscured, but also such that it ensured the word would be central to the face. Stenberg et al (1998) located the words across the bridge of the nose, therefore that location was considered the most suitable for the current study. An example of the compound stimuli can be seen in figure 3.1 (below). The full sets of face-word pairs are presented in appendices VI and VII.



Figure 3.1. An exemplar of the compound stimuli presented to the participants during the selective attention task

This procedure resulted in two sets of compound stimuli consisting of the two sets of facial expressions but with the same set of emotional words (see appendices VI & VII). The rationale for creating two sets of stimuli was to control for the distinctiveness of the individuals portraying the facial expressions, as this was considered likely to influence the extent to which an image would be distracting. Thus, any differences in valence identification times might be a consequence of attention capture by distinctive faces rather than the emotional content of the faces. Likewise, any advantage for particular words at recognition memory testing might also be ascribed to the distinctiveness of the faces that they were superimposed upon rather than the emotional content of these faces. The participants were randomly assigned to receive only one of the sets during the selective attention task. Four extra face-word pairs (four neutral faces paired with 1 positive, and 1 negative word and 2 neutral words) were created to act as buffer stimuli (see appendix VIII). Two of these stimuli appeared at the beginning and two at the end of the selective attention task in order to minimise primacy and recency effects on the recognition memory task (responses to these stimuli were not included in any analysis). Six more face/word

pairs were produced and were presented during the practice phase of the selective attention task (see appendix VIII). All of these pairs consisted of a neutral face paired with a different emotional word (2 positive, 2 neutral & 2 negative).

3.2.3.4. Assessment of Psychomotor Speed

The Digit Symbol Substitution Task (DSST) was drawn from the Wechsler Adult Intelligence Scale – revised version (WAIS-R; Wechsler, 1981) in order to provide a measure of general psychomotor speed and also to act as a distracter task during the five-minute delay period between encoding (selective attention) and memory phases.

3.2.3.5. Stimulus Presentation

An AppleMac PowerBook 3004 laptop computer loaded with the SuperLab[®] program version 1.5.7. (Cedrus Corporation, 1992; Phoenix, Arizona) was used to present the stimuli (in a random order) and to measure and record the participants' responses to the stimuli. The size of the computer screen was 260mm by 175mm and the face/word stimuli were 125mm (height) by 75mm (width). The words were printed in 24-point font size, with the letters appearing seven millimetres in height on the screen. The rationale for the attention task was that the participants would have to inhibit their responses to the faces in order to correctly respond to the words. However, if the face/word pairs always appeared in the same location (e.g. the centre of the screen) the participants could apply a strategy of narrowing their focus of attention to the point where the word appears, thus lessening the impact of the faces. It has been reported (e.g. Hertel, 1997) that depressed patients are less likely to adopt strategies than healthy individuals, thus any apparent differences between the groups could have been ascribed to differences in strategy use and not differences in controlled attention.

Therefore, in order to prevent use of such strategies the position of the face/word pairs on the screen was manipulated such that the stimuli appeared randomly in one of nine different positions on the screen (top left, top centre, top right, centre left, centre of screen, centre right, bottom left, bottom centre and bottom right). During the recognition memory test the (*novel & familiar*) words (in bold 24-point text) were presented in a random order in the centre of the screen. The words remained on screen until the participant pressed a key.

3.2.4. Procedure

3.2.4.1. Selective attention task

The participants were presented with one of the sets of face/word pairs (*A or B*) and were informed that they should focus on the words and disregard the faces (as in Stenberg et al, 1998). The participants were informed that their task was to indicate, by pressing one of three marked keys, whether they considered the emotional meaning of the words to be *positive*, *neutral* or *negative*. The participants were informed that they should try to do this as quickly and accurately as possible. A reminder of the position of the *positive*, *neutral* and *negative* keys was provided in the form of a card that lay across the keyboard adjacent to the response keys, so that the participants could see which key related to which emotion even when their fingers were covering the response keys. Prior to the actual test session there was a short practice phase of six face/word pairs to ensure that the participants understood the task. The participants were then required to progress to the main set of stimuli (once they had been given an opportunity to ask any questions they might have concerning the task). Upon completion of the selective attention task they were asked to complete the Digit Symbol Substitution task (DSST). Following the standard procedure, the

participants were given 90 seconds to complete as many symbol substitutions as they could. Participants were then asked to complete the BDI and HADS mood questionnaires. Once a five-minute delay period had elapsed the participants were given a recognition memory test for the words they had seen during the selective attention task.

3.2.4.2. Recognition memory task

The participants were presented with a set of 72 words (*36 familiar & 36 novel*), in a random order, one at a time in the centre of the screen. They were asked to indicate for each word whether or not they recognised it from the initial phase of the experiment. They were asked to do this by pressing one of two marked keys ("yes" or "no"). As in the selective attention task, a card reminding the participants of which key related to which response was positioned on the keyboard above the response keys. Once all of the words had been viewed and judged the participants were asked to complete the National Adult Reading Test.

3.2.4.3. Data Analysis

The participant characteristics (e.g. age, years of full-time education completed etc) and scores on the mood measures were analysed using a MANOVA with group as the independent factor. The participants' data from the selective attention phase (*response times & the percentage of errors*) and the recognition memory phase (*percentage of words correctly recognised*) were analysed using a 3 (*face valence; happy, sad & neutral*) x 3 (*word valence; positive, neutral & negative*) repeated measures ANOVA with group (*depressed & control*) as the between subjects factor. Pair-wise analyses of significant main effects were analysed using least significant difference (LSD)

tests, when a-priori predictions had been made and Bonferroni tests where no such predictions had been made. Subsequent investigations of significant interactions were carried out using *one-way* and *two-way* ANOVA and paired t-tests (for within subject comparisons) or independent t-tests (for between group comparisons). The alpha level of subsequent t-tests was adjusted where appropriate using Holms Sequential Bonferroni Correction Method (Green & Salkind, 2003). The association between participant group and false recognition of the different 'lure' words was analysed using chi-squared tests.

3.3. Results and Discussion (Selective Attention Task)

3.3.1. Participant characteristics

Analysis of the participants' characteristics (table 3.1) revealed that the two groups were well matched in terms of age; $F(1, 62)=2.5$, $p>0.05$ and educational level (*years of full-time education completed*); $F(1, 62)=2.5$, $p>0.05$ and pre-morbid intelligence (*estimated from the number of reading errors committed by the participants' on the NART*); $F(1, 62)=2.2$, $p>0.05$. It should be noted that although the two groups did not differ significantly in terms of their general intellectual ability, the estimated full-scale IQ scores of both groups are relatively high. This finding might represent a sampling bias, as perhaps patients with a higher IQ were more likely to agree to participate, or perhaps the psychiatrists were more likely to consider these patients as suitable for the study.

Analysis of the participants self-rated mood revealed that, as expected, the patients rated themselves as significantly more depressed than did the controls, on both the BDI; $F(1, 62)=198$, $p<0.0001$ and HADS depression scale; $F(1, 62)=304$, $p<0.0001$.

Furthermore, the patients rated themselves as significantly more anxious than did the controls on the HADS anxiety scale; $F(1, 62)=151$, $p<0.0001$. As it has been consistently been reported that anxiety is also associated with marked changes in cognitive function, particularly of selective attention (see section 1.3.6, page 15), it was considered appropriate to control for the influence of anxiety when analysing the data of the current study. Details of the analyses conducted to control for the influence of anxiety on task performance can be found in appendix IX.

Table 3.1. Characteristics of the individuals making up the two participant groups

	Depressed (N=32)	Controls (N=32)	P-value
Age	40.7 (10.1)	42.1 (9.6)	NS
Sex	19 Females, 13 Males	19 Females, 13 Males	-
Years of FTE	12.1 (2.5)	13.0 (2.4)	NS
Predicted IQ	113 (5.8)	115 (4.6)	NS
DSST	42.8 (9.7)	55.8 (9.2)	< 0.0001
BDI	29.0 (10.2)	2.8 (2.6)	< 0.0001
HADS (A)	14.2 (4.3)	3.3 (2.6)	< 0.0001
HADS (D)	13.6 (3.9)	1.1 (0.9)	< 0.0001
HRSD	20.0 (4.4)	N/A	-

FTE = Full-time Education, BDI = Beck Depression Inventory (21-item), HADS (A) = Hospital Anxiety and Depression Scale (Anxiety Score), HADS (D) = Hospital Anxiety and Depression Scale (Depression Score), HRSD = Hamilton Rating Scale for Depression (17-item) and DSST = Digit Symbol Substitution Task score.

In line with previous studies (e.g. Ilesley et al., 1995) the patients demonstrated impaired performance on the Digit Symbol Substitution Task relative to the controls;

$F(1,62)=30.2$, $p<0.0001$. This finding suggests that, relative to the healthy controls, the patients exhibited significant psychomotor slowing.

3.3.2. Valence Identification Times

Based on the findings of Stenberg et al (1998) it was expected that, participants would be significantly slower to identify the valence of the words paired with incongruent faces than those paired with congruent or non-congruent (neutral) expressions. In line with this prediction, analysis of the participants valence identification times (presented in table 3.2) revealed a significant face valence x word valence interaction (illustrated in figure 3.2); $f(2, 124)=9.1$, $p<0.001$.

Table 3.2. Mean valence identification time (in milliseconds), as a function of the type of facial expression upon which the words were superimposed during the selective attention task (*one standard error presented in parentheses*)

Face	Word	Depressed	Controls
Valence	Valence	(N=32)	(N=32)
Happy	Positive	1641 (84)	1221 (33)
	Negative	1837 (105)	1339 (42)
Neutral	Positive	1664 (78)	1207 (31)
	Negative	1761 (97)	1269 (41)
Sad	Positive	1837 (85)	1196 (31)
	Negative	1674 (74)	1231 (45)
TOTAL		1736 (76)	1244 (31)

Inspection of the data presented in figure 3.2 revealed that overall participants were significantly slower to identify the valence of the positive words when they were paired with sad expressions ($\mu=1516$, $SE=60$) than when they were presented with happy ($\mu=1664$, $SE=78$) or neutral expressions ($\mu=1664$, $SE=78$); $t(63)=2.2$, $p<0.05$ and $t(63)=2.7$, $p<0.05$ respectively.

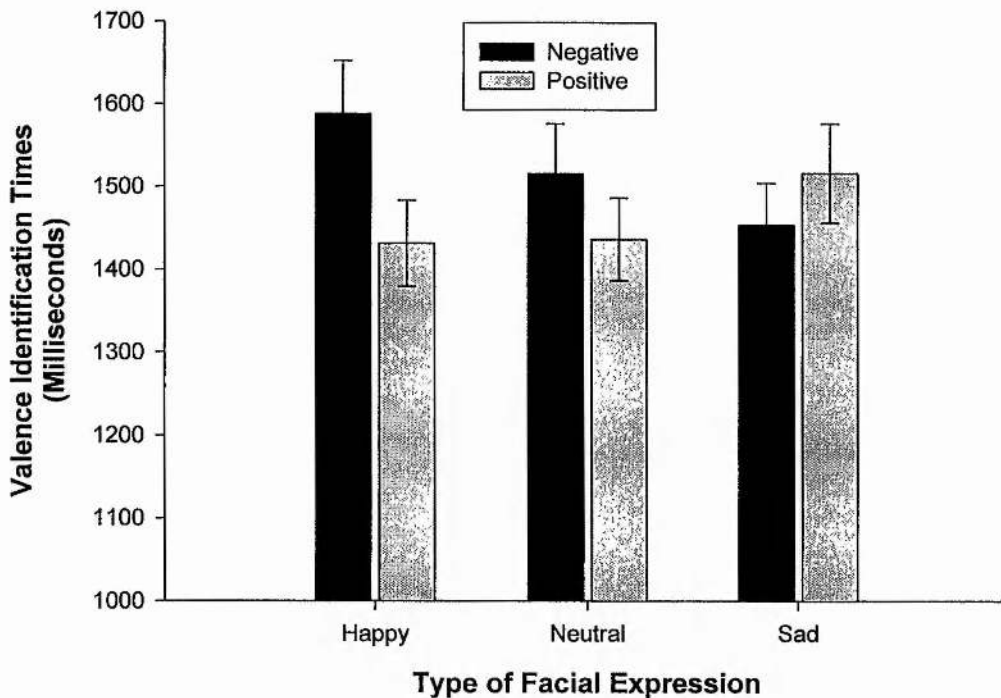


Figure 3.2 Mean valence identification times for the positive and negative words paired with happy, neutral and sad faces (error bars represent \pm one standard error of the mean)

Positive word identification times for words paired with happy and neutral expressions did not differ significantly, $p>0.05$. Furthermore, analysis of the participants' valence identification times also revealed that negative words were identified significantly slower when they were paired with happy expressions ($\mu=1588$, $SE=64$) than when they were presented with sad ($\mu=1453$, $SE=51$) or

neutral ($\mu=1515$, $SE=61$) faces. Negative word identification times did not differ significantly when the words were paired with sad or neutral faces, $p>0.05$. It should also be noted that the participants in both groups demonstrated a positive word identification advantage as positive words were identified significantly faster ($\mu=1461$, $SE=50$) than were negative words ($\mu=1519$, $SE=54$), $f(1, 62)=6.3$, $p<0.05$.

In line with the findings of Stenberg et al (1998) it was also expected that the controls would demonstrate a positive word identification advantage (evidenced by faster identification times) that would be enhanced when the words were paired with happy faces and abolished when the words were presented with sad facial expressions. Conversely, based on Murphy et al (1999) it was expected that depressed patients would demonstrate a negative word identification advantage that would be enhanced when the words were presented with sad faces and abolished when the words were paired with happy expressions. In line with these predictions, analysis of the valence identification times revealed a significant group \times face valence \times word valence interaction, $f(2, 124)=4.0$, $p<0.05$. In order to elucidate the nature of this three-way interaction the identification times for positive and negative words were analysed separately using 2 (group) \times 3 (face valence) repeated measures ANOVA.

Analysis of the valence identification times for positive words revealed a significant group \times face valence interaction (illustrated in figure 3.3); $f(2, 124)=6.1$, $p<0.01$. Subsequent analysis revealed that, contrary to the predictions, controls' valence identification times for positive words did not differ significantly as a function of face valence. However, depressed individuals were significantly slower to identify positive words when they were paired with sad faces ($\mu=1836$, $SE=85$) than when they were

presented with neutral ($\mu=1664$, $SE=78$) or happy expressions ($\mu=1641$, $SE=84$); $t(31)=3.3$, $p<0.01$ and $t(31)=2.8$, $p<0.01$ respectively.

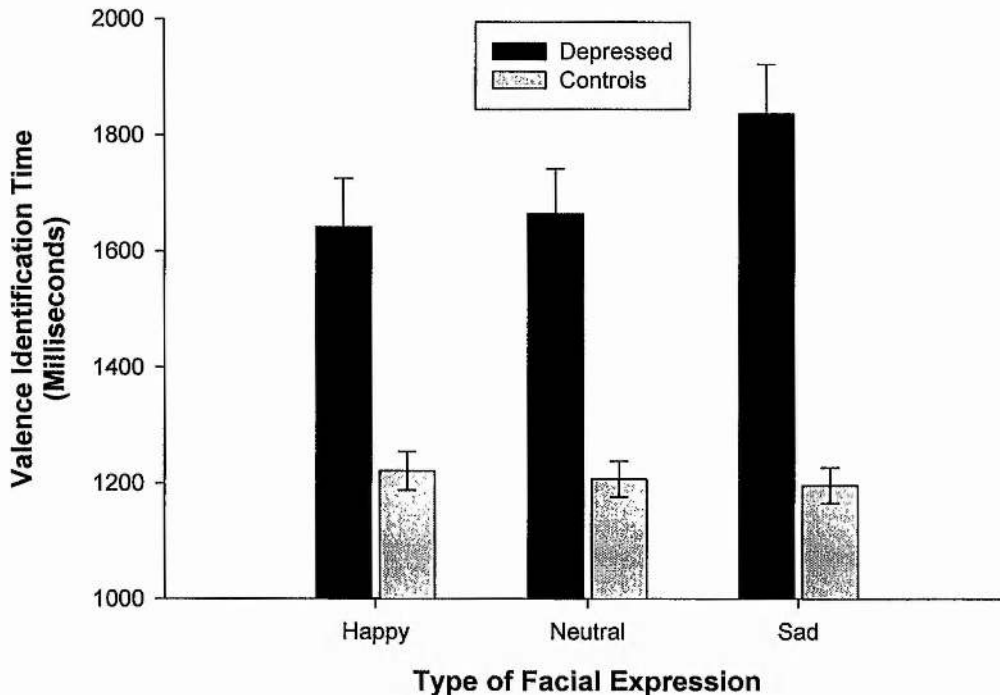


Figure 3.3. Mean valence identification times for the positive words paired with happy, neutral and sad faces, as a function of participant group (error bars represent \pm one standard error of the mean)

Analysis of the negative word identification times revealed a significant main effect of face valence (illustrated in figure 3.4); $f(2, 124)=5.5$, $p<0.01$. Subsequent analysis revealed that the participants' negative word identification times were significantly slower when the words were paired with happy faces ($\mu=1588$, $SE=64$) than when they were presented with neutral ($\mu=1664$, $SE=78$) or sad faces ($\mu=1664$, $SE=78$); $p<0.05$ and $p<0.01$ respectively. Negative word identification times were also slower when the words were paired with neutral faces than when they appeared with sad

faces, but this difference was not significant, $p=0.13$. There was no significant group x face valence interaction; $F<1$.

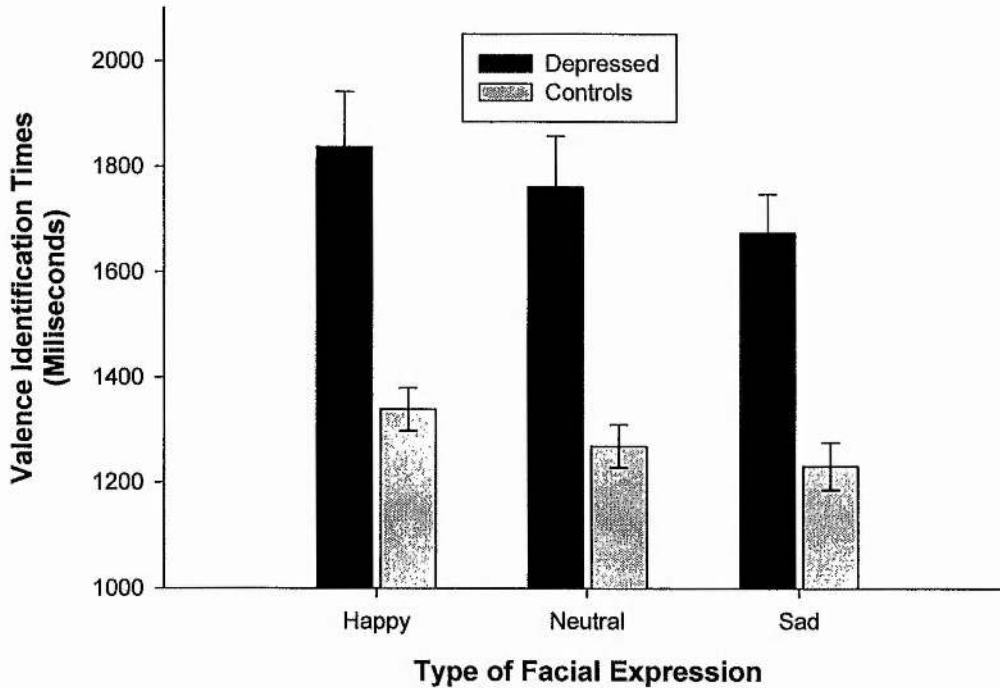


Figure 3.4. Mean valence identification times for the negative words paired with happy, neutral and sad faces, as a function of participant group (error bars represent \pm one standard error of the mean)

In line with previous studies (e.g. Gotlib & Cane, 1987) it was predicted that depressed individuals would be significantly slower to identify the valence of the neutral words when they were paired with sad faces than when they were presented with happy or neutral expressions. However, it was not expected that the neutral word identification times for the controls would differ as a function of the type of facial expressions these words were presented with.

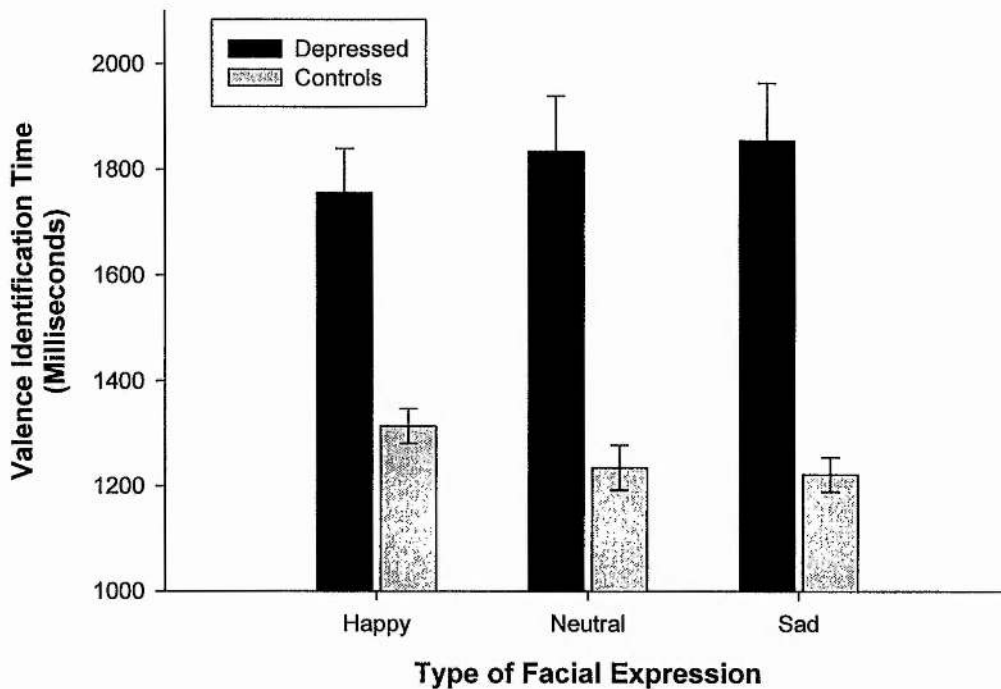


Figure 3.5. Mean valence identification times for the neutral words paired with happy, neutral and sad faces, as a function of participant group (error bars represent \pm one standard error of the mean)

Analysis of the data presented in figure 3.5 revealed a significant group \times face valence interaction; $f(2, 124) = 3.8$, $p < 0.05$. Further analysis revealed that contrary to the prediction (outlined above) depressed individuals' valence identification times for neutral words were not significantly influenced by the type of facial expression the words were presented with; happy ($\mu = 1755$, $SE = 84$); neutral ($\mu = 1834$, $SE = 105$) and sad ($\mu = 1834$, $SE = 109$) respectively; all tests $p > 0.05$. However, controls were significantly slower to identify the valence of the neutral words presented with happy faces ($\mu = 1314$, $SE = 33$) than those paired with neutral ($\mu = 1235$, $SE = 43$) or sad faces ($\mu = 1222$, $SE = 33$); $t(31) = 2.7$, $p < 0.05$ and $t(31) = 4.1$, $p < 0.001$ respectively.

The finding that participants were slower to identify positive words paired with sad faces than those presented with happy or neutral expressions provides support for the first hypothesis. Likewise, the finding that the participants were slower to identify negative words paired with happy faces than those paired with neutral or sad expressions also supports the first hypothesis. These findings correspond with Stenberg et al (1998) and suggest that emotional valence of faces is processed automatically and that this processing is able to influence other ongoing cognitive activity. However, the finding of a three-way group x face valence x word valence interaction suggests that the two groups of participants may have been differentially affected by the interaction of the faces and words. These findings will now be considered.

The finding that the controls' positive word identification times did not differ as a function of face valence does not support the second hypothesis. Likewise, this finding is not consistent with the results of Stenberg et al (1998). This result suggests that the faces were not influencing the ongoing processing of the participants in the control group. By contrast, there was strong evidence that the valence of the face the words were paired with exerted a significant influence on the positive word identification times of the depressed patients. This finding is consistent with previous work that has reported that depression is associated with impaired ability to inhibit distracting "off-task" stimuli (e.g. MacQueen et al, 2000). One possible explanation of the failure to replicate the positive emotion bias that was reported in Stenberg et al (1998) is that there is a marked difference in the ages of the samples in the two experiments, as the mean age of the current sample is 41 compared to a mean age of 22 in Stenberg et al (1998). A second possibility is that there may have cultural

differences between the two samples, as the original participant sample was from Sweden and the current sample is Scottish. However, another possibility concerns depressive symptoms in the participant samples. In the current study it was the depressed sample that demonstrated changes in identification times as a consequence of face valence and it is therefore plausible that a number of the participants in Stenberg et al (1998) may have been experiencing dysphoria that was not controlled for in their study.

The finding that the negative word identification times of both groups of participants were significantly influenced by the valence does not support the second prediction of hypothesis two as depressed individuals were not shown to exhibit a negative word advantage. Similarly the finding from the main analysis that all participants demonstrated a positive word identification advantage was not consistent with the second hypothesis. However, there is evidence from negative word identification to suggest that the processing of healthy individuals was also subject to interference from the distracting stimuli. For both groups the effect seems to be primarily that the incongruent faces (happy) were impairing their negative word identification. However, there was also a non-significant tendency towards the priming of the negative words when they were presented with sad faces. Although both groups of participants exhibited marked slowing of negative word identification in the presence of happy expressions, it is possible that the processes underlying this slowing are different for the two groups. For instance it is likely that the slowing in the depressed patients represents a general impairment relating to an inability to inhibit distracting 'off-task' stimuli. Conversely, it is possible the slowing in the control group related to a selective attention bias towards happy faces.

The finding that the faces did not influence the depressed individuals' neutral word identification times does not support the presence of the predicted selective attention bias for sad faces in depressed individuals. Conversely, the findings that the controls were significantly slower to identify neutral words paired with happy faces compared to those paired with neutral or sad faces does suggest that healthy mood is associated with an attention bias towards happy faces. These findings correspond with those of Gotlib et al (1988) who reported that healthy individuals exhibited an attention bias towards positive stimuli, whereas depressed patients exhibited no preferential processing of the different types of stimuli.

The findings of the current study suggest that depressed individuals had difficulty in dealing with cognitive conflict, as they demonstrated slowed identification of word valence only when the words were presented with incongruent faces. This finding is in line with those of MacQueen et al (2000), who reported that depressed individuals failed to inhibit distracting "off-task" stimuli. These findings are also consistent with studies that have reported that depressed individuals are impaired on the traditional Stroop colour-naming task (e.g. Lamelin et al., 1997; Trichard et al, 1995). Moreover, as the selective attention task in the current study is essentially a Stroop task then it would seem feasible that the observed interference demonstrated by the patients could relate to the same dysfunction in the anterior cingulate that has been reported in depressed patients in previous studies (e.g. Bench et al, 1992; Drevets et al, 1992; Drevets et al, 1997; Goodwin et al, 1993). This assumption is consistent with the findings of George et al. (1997) who reported that impaired performance of depressed patients on the Stroop task related to blunted activation in the AC. This could be tested in future using functional brain imaging techniques (e.g. fMRI) to identify

which brain regions are recruited by depressed patients and healthy controls to perform this emotional Stroop task. It would also be possible to obtain further evidence using a more traditional neuropsychological approach of comparing the performance of depressed and non-depressed individuals on both the novel face-word variant of the emotional Stroop task (utilised in the current study) and the traditional Stroop task, in order to establish if the participants' performance on the two tasks was significantly related.

3.3.3. Percentage of Valence Identification Errors

In line with Stenberg et al (1998) it was predicted that, overall, participants would make significantly more valence identification errors when the words were paired with incongruent facial expressions than when they were presented with congruent or non-congruent faces. However, preliminary analysis revealed that the percentage of identification errors made by the participants in the control group was very low ($\mu=1.9\%$, $SE=0.6$) compared to the depressed patients ($\mu=17.5\%$, 3.9); therefore analysis was only conducted on the percentage of identification errors made by the depressed patients.

Analysis of the percentage of valence identification errors made by the depressed individuals (illustrated in figure 3.6) revealed a significant face valence x word valence interaction, $f(2, 62)=4.6$, $p<0.01$. There was no significant effects of face valence or word valence; $f(2, 62)=1.1$, $p>0.05$ and $f(1, 31)=1.5$, $p>0.05$ respectively. In order to elucidate this interaction the percentage of positive and negative identification errors made by the depressed individuals was analysed separately using one-way repeated measures ANOVA with face valence as the within subjects factor.

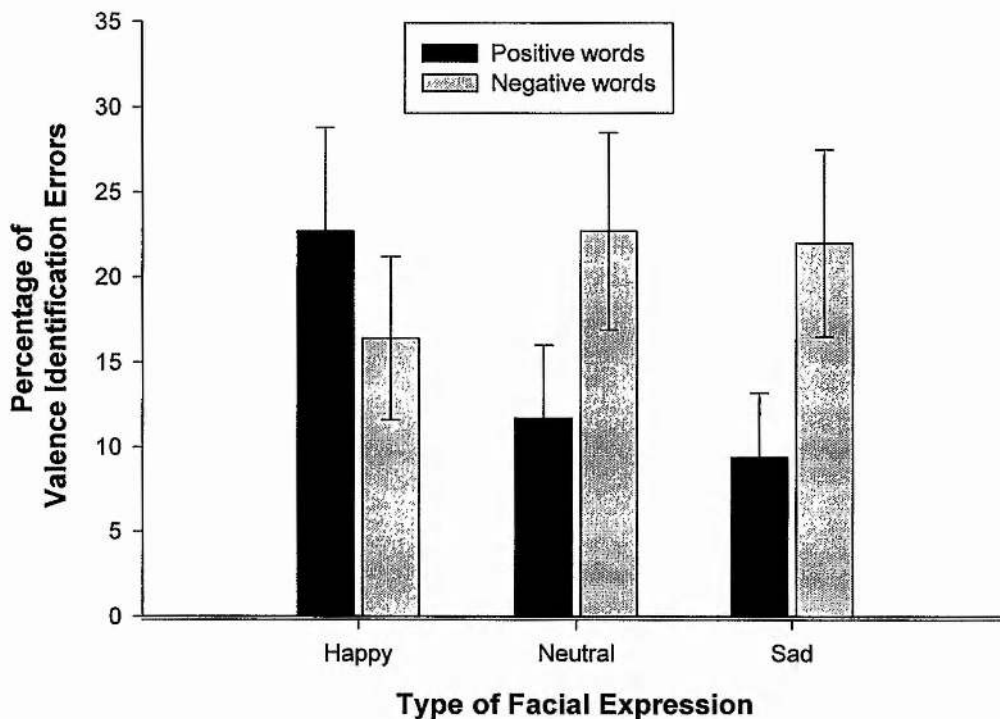


Figure 3.6. Mean percentage of positive and negative word identification errors made by the depressed patients, as a function of face valence (error bars represent \pm one standard error of the mean)

Analysis of the percentage of positive word identification errors revealed that the number of errors did not differ significantly as a function of face valence; for either happy ($\mu=16.4\%$, $SE=4.8$), neutral ($\mu=22.7\%$, $SE=5.8$) or sad faces ($\mu=22.0\%$, $SE=5.5$); $f(2, 62)=1.1$, $p>0.05$. Conversely, the percentage of negative word identification errors differed significantly as a function of the valence of the faces the words were presented with; $f(2, 62)=5.7$, $p<0.001$. Overall, depressed individuals made significantly more identification errors when the negative words were paired with happy expressions ($\mu=22.7\%$, $SE=6.1$) than when they were paired with neutral ($\mu=11.7\%$, $SE=4.3$) or sad faces ($\mu=9.4\%$, $SE=3.8$); $p<0.05$ and $p<0.01$ respectively.

Further analysis of the percentage of word identification errors revealed that when the words were paired with neutral faces the depressed participants made significantly more positive than negative identification errors; $t(31)=2.0$, $p<0.05$ (one-tailed). Similarly, when the words were presented with sad faces the depressed individuals made significantly more positive than negative errors; $t(31)=2.3$, $p<0.05$. However, when the words were paired with happy faces this pattern was reversed, the depressed individuals made more negative than positive errors, but this difference was not significant, $p>0.05$.

From hypothesis four it was expected that depressed individuals would be more accurate when responding to negative words than neutral or positive. The evidence reported above provides some support for this proposal, as the depressed patients appear to demonstrate a negative word identification advantage in the neutral face condition that is enhanced slightly in the presence of the sad faces. However, the presence of the happy faces appears to have reversed this advantage, again providing evidence that the concurrent processing of the 'off-task' information significantly altered ongoing cognitive activity.

3.3.4. Is the face-word task strictly a test of selective attention?

Tasks that have been used in previous studies to address selective attention in major depression have tended to involve the presentation of a neutral element and an emotional item. These stimuli are either presented in the same physical space; as in the emotional Stroop task, where the emotional element (an emotional word) is combined with the neutral component (an ink colour), or in different locations as in the dot probe task, where the emotional stimulus (e.g. an angry face) and neutral item

(e.g. a neutral face) appear at different locations. In these types of studies it is possible to make inferences about differences in the allocation of attention based on patterns of colour-naming times or relative differences in response times to the probes. The face-word variant of the Stroop task that was utilised in the current study was originally designed by Stenberg et al (1998) to investigate the extent to which emotional faces were processed automatically and whether this processing influenced other ongoing cognitive activity. There are, however, a number of similarities between this paradigm and the other tasks that have been used to tap selective attention for emotional material in depression. For example, a number of stimuli in the current study involved a neutral stimulus paired with an emotional item (e.g. a neutral face paired with a positive or negative word, or an emotional face paired with a neutral word). Despite these similarities, there are also clear differences between the face-word task and the other selective attention tasks. For example, many of the compound stimuli presented during the current study consisted of two emotional elements (e.g. a sad face with a positive word). It could be argued that where the face-word pairs were incongruent (e.g. happy face/negative word or sad face/positive word) the task closely resembled the original Stroop task, i.e. in the original Stroop task both elements were colour-relevant and in the current face-word task both elements were emotion-relevant. It is clear, however, that where the face-word pairs were congruent (happy face/positive word or sad face/negative word) the task was not addressing selective attention but rather emotional priming.

It would seem clear that evidence of slowed valence identification in the incongruent conditions could be interpreted as the automatic processing of the to be-ignored stimulus interfering with the processing of the to-be-attended stimulus, in line with

explanations of the traditional Stroop task. Slowed identification of neutral words in the presence of happy faces, as demonstrated by the controls, could be interpreted as a consequence of the participants' attention being captured by the happy faces, in line with the logic applied in explaining the changes in colour-naming times in studies using the emotional variant of the Stroop task. More rapid identification of words presented in congruent condition would have provided evidence of emotional priming, similar to that demonstrated in Stenberg et al (1998). However, there was no evidence of this phenomenon in the current study. Overall, it can be argued that the face-word task employed in the current study does address elements of selective attention in similar ways to other common attentional tasks. However, it also provides interesting and important information concerning how individuals (depressed & non-depressed) allocate attention in conditions where two conflicting emotional cues occupy the same spatial location. The data produced by the face-word task is very complex and requires careful analysis in order to understand the findings. In future it would be advisable to try and simplify the design to look separately at emotional priming and selective attention.

3.3.5. Summary and Conclusions (Selective Attention Task)

Taken together, the evidence from the valence identification times and percentage of errors revealed that, contrary to the predictions, depressed individuals did not demonstrate a selective attention bias for sad facial expressions. Conversely, evidence from the identification times revealed that the controls exhibited an attention bias for the happy faces. This supports the notion that depressed individuals are even-handed in their processing, whereas healthy individuals tend to see the world through "rose-tinted" spectacles (e.g. Gotlib et al, 1988). It would seem likely that reduced attention to positive stimuli in their environment might have consequences for the severity and

duration of the patients' depressive episode. For example, if a depressed person, was in conversation with a significant other, and failed to attend to the conversational partner's smiling face this could negatively influence the interpretation of the interaction. There was support for the predicted congruence/ incongruence effect on valence identification times. However, it appears that it was depressed participants and not controls that exhibited changes in positive word identification as a function of face valence. Contrary to the findings of Stenberg et al (1998) healthy controls did not exhibit an emotional bias for positive words. Explanations for this non-replication include differences in participant variables (e.g. age, depression) or possibly cultural differences. In line with previous studies (e.g. MacQueen et al, 2000) the patients demonstrated impaired inhibition of distracting "off-task" stimuli, indexed by significantly slowed identification times in circumstances that involved incongruent face/word pairs. It is plausible that this relates to a dysfunction of the anterior cingulate in the depressed sample. Overall, depressed individuals were more accurate in their identification of negative words, possibly due to their expertise in processing these words. However, this advantage disappeared when the negative words were presented with incongruent (happy) faces, possibly due to the increased cognitive demands of trying to resolve the conflict in meaning between the incongruent faces and words.

3.4. Results and Discussion (Recognition Memory Task)

3.4.1. *Percentage of correct recognitions*

Preliminary analysis revealed that the percentage of neutral words correctly recognised by the participants did not differ significantly across the different face

conditions; therefore full analysis was conducted on only the percentage of positive and negative words that were correctly recognised at memory testing.

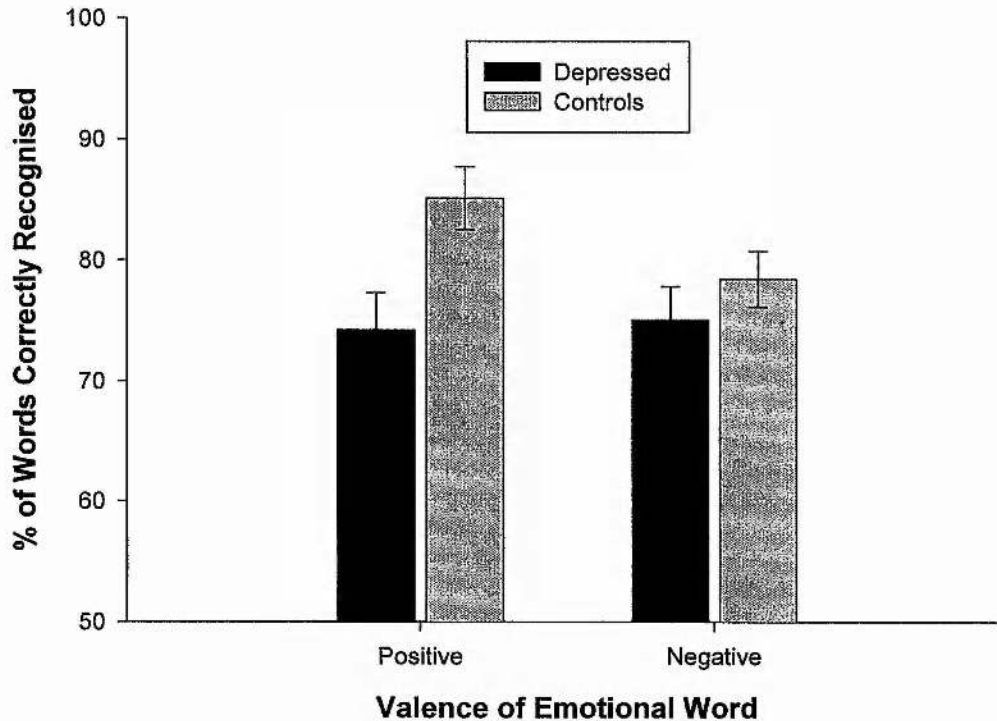


Figure 3.7. Percentage of positive and negative words correctly recognised by the participants during recognition memory testing

Hypothesis three predicted that, *“depressed individuals would correctly recognise significantly more of the negative words than the neutral or positive”*. In line with this prediction, analysis of the percentage of words correctly recognised by the participants during memory testing revealed evidence of an interaction between group and word valence (illustrated in figure 3.5), which approached conventional significance, $F(1, 62)=3.1$, $p=0.08$. However, further analysis of this interaction revealed that the depressed patients recognised a similar number of positive ($\mu=74.2\%$, $SE=3.1$) and negative words ($\mu=75.0\%$, $SE=2.8$) during memory testing,

which does not support the prediction (outlined above). Nevertheless, this analysis did reveal that the depressed patients correctly recognised significantly fewer positive words than did the controls ($\mu=85.1\%$, $SE=2.6$), $t(62)=2.7$, $p<0.01$. Furthermore, depressed individuals did not differ from the controls in terms of the number of negative words that they correctly recognised (μ depressed= 75.0% , $SE=2.8$; μ controls= 78.4% , $SE=2.3$), $p>0.05$. Also of note was the finding that the controls correctly recognised significantly more positive than negative words during memory testing, $t(31)=2.4$, $p<0.05$.

It was also predicted in hypothesis three that, *"the mood congruent memory bias in depressed patients would be moderated by the valence of the faces the words were paired with at encoding, such that patients would recognise significantly more of the negative words that were paired with sad faces than those that were paired with happy or neutral expressions"*. However, analysis of the percentage of words correctly recognised by the participants during memory testing did not reveal the expected group x face valence x word valence interaction, $F<1$. Therefore this prediction was not supported by the results of the current study.

The findings of the current study did not provide evidence of the predicted negative memory bias in the patient sample. However, the patients demonstrated impaired recognition memory of the positive words relative to the controls, which could be interpreted as a negative bias. Participants in the control group demonstrated a positive memory bias, as they exhibited superior memory for positive words relative to negative words. This positive memory bias in the control sample corresponds with the pattern of memory observed for non-depressed individuals in previous studies

addressing mood-congruent memory bias in depressed individuals (see Matt et al, 1992 for a review). The failure to demonstrate the predicted MCM bias for the depressed patients in the current study may be accounted for in terms of elaborative processing. Inspection of the valence identification times from the selective attention task (see table 3.2, page 78) revealed that depressed individuals failed to inhibit the distracting faces, hence the valence identification task would have been highly demanding for the patients in terms of cognitive resources. As a consequence the patients may have had fewer cognitive resources to allocate to the elaboration of the words. Conversely, the controls' processing of the positive words was relatively unaffected by the presence of the faces, hence they would have been able to selectively allocate more resources to the elaboration of the positive words.

3.4.2. Signal Detection Analysis

As recognition memory performance is susceptible to distortions due to response biases on the part of the participant, signal detection analysis (Swets, 1961) was conducted on the recognition memory data in the current study in order to establish if the group x valence interaction was still observed when the participants' response style was controlled for. The signal detection parameter d' (calculated from the number of "hits") indicates the relative sensitivity of the participants to the different stimuli, with higher values indicating superior "pure" memory for the stimuli (i.e. memory performance that is independent of response style). The parameter β (calculated from the number of "false positives") indicates the participants' response style to the different types of stimuli, with higher values indicating the application of more conservative criterion for rejecting words as being previously viewed. However, analysis of these data (presented in table 3.3) revealed that, once the response style of

the participants was controlled for, the group x valence interaction was no longer significant, $F < 1$. This finding suggests that the controls' memorial advantage for positive words related to a tendency to falsely recognise positive words. However, analysis of the participants' β scores revealed no significant main effects or interaction.

Table 3.3. Mean d' and β values calculated from the participants responses to the positive and negative words during recognition memory testing

Group	Word Valence	Sensitivity (d')	Response Style (β)
Depressed	Positive	0.93 (0.06)	1.4 (0.7)
	Negative	0.71 (0.1)	1.3 (0.7)
Controls	Positive	1.2 (0.05)	1.6 (0.1)
	Negative	0.9 (0.07)	1.5 (0.07)

3.4.3. False recognition of non-presented "lure" words

There was some evidence in support of the prediction that "*depression-relevant 'lures' would be falsely recognised by significantly more of the depressed patients than the controls*", as more of the patients falsely recognised the lure word "sad" than would be expected, whereas fewer of the controls recognised it than would be expected (see table 3.4, below).

Analysis of this data using a chi-squared test revealed that this observed association between participant group and falsely recognising the word "sad" was significant, $\chi^2(1)=5.3$, $p < 0.05$. However, evidence from the analysis of the number of participants in each group that falsely recognised the lure word "depressed" provided less

convincing evidence of the predicted tendency. Although more of the depressed individuals ($n=16$) falsely recognised the lure “depressed” than would be expected ($n=14$), and less of the controls ($n=12$) falsely recognised this word than would be expected ($n=14$), the test of this association only suggested a non-significant trend in the predicted direction, $\chi^2(1)=1.1$, $p=0.15$.

Table 3.4. Number of participants in each group that falsely recognised the lure word “sad” (expected frequencies are shown in parentheses)

	Falsely recognised “sad”?	
	Yes	No
Depressed	17 (12.5)	15 (19.5)
Controls	8 (12.5)	24 (19.5)

This tendency towards false recognition of depression-relevant lures cannot be explained in terms of a greater tendency of the patients to falsely recognise non-presented words, as there was no difference in the number of participants in each group that falsely recognised the lure words “charming” and “excited”. There was no significant association in either case, $p>0.05$. The tendency of the patients to falsely recognise depression-relevant words corresponds with the findings of Segal et al (1995), who proposed that depression-relevant material is highly organised and interconnected in the cognitive systems of depressed individuals. They suggested that presentation of one element of this representation would, due to the highly organised interconnections, increase the accessibility of related material.

3.4.4. Summary and Conclusions (Recognition Memory Phase)

Contrary to the predictions, the depressed individuals did not demonstrate superior recognition memory for the depression-relevant words. Furthermore, they did not demonstrate the predicted enhanced memory for negative words paired with sad faces. There was some evidence that the controls demonstrated a bias towards superior recognition memory of the positive words. However, when the recognition memory data were subjected to a signal detection analysis it was apparent that high levels of false recognition of positive words may have contributed to the memory bias exhibited by the controls. As predicted, there was some evidence to suggest that depressed individuals were more likely to falsely recognise the depression-relevant "lures" than were the controls, which probably related to the highly interconnected nature of depression-relevant material in the cognitive systems of the patients. It would seem clear that the observed impairment of memory for positive memories in depressed patients, coupled with their tendency towards false memories of negative memories could act to bias recollection of events in which they are involved, leading the patients to remember events as more negative than they actually are. This tendency could, therefore, further contribute to the patient's low mood.

3.5. General Discussion

3.5.1. *The influence of emotional facial expressions on processing of concurrently presented affective words*

Overall it would appear that, relative to the controls, the faces exerted a greater influence on the processing of the depressed patients. Primarily depressed patients demonstrated impaired inhibition of the faces, evidenced by slower valence identification times for incongruent than congruent face-word pairs. However, the

presence of the faces also exerted specific valence-related effects on the profile of cognitive processing exhibited by the patients. For example, the presence of happy faces reduced the patients' apparent identification advantage for depression-relevant words, whereas the presence of the sad faces appeared to enhance this bias. In terms of recognition memory performance the most striking finding of the current study is the failure to demonstrate the robust MCM bias for depression-relevant words in the depressed patients. It is proposed that as the patients were processing all elements of the compound stimuli (faces & words) they may have had fewer cognitive resources to apply to the elaboration of the negative words.

Although the faces clearly exerted greater influence on the processing of the depressed patients, there was also evidence that they significantly influenced the processing of the healthy controls. The most notable finding was the positive attention bias evident for happy faces. Initial inspection of the data would appear to suggest that the faces did not influence the memory of the controls, as the evidence supports that they exhibited the expected MCM bias for positive words. However, signal detection analysis revealed that the observed superior memory performance related to a response bias in terms of falsely recognising positive words. It is possible that the inhibition of the faces at encoding also reduced resource capacity of the controls, preventing them from elaboratively encoding the positive words. It is possible that at recognition memory they were relying on a feeling of familiarity as opposed to an actual recollection of the different words. This could be tested in future using the remember-know paradigm (Gardner & Java, 1993).

3.5.2. *Methodological Considerations*

During the recognition memory phase of the study conducted by Stenberg et al (1998) the words were presented with faces (half the same face and half different). However, in order to simplify the procedure in present experiment it was decided to present the words alone. This also enabled examination of the influence of distracting stimuli at encoding alone (i.e. if the faces were not present at retrieval then any observed effects on memory must relate to conditions at encoding). However, Stenberg and colleagues suggested that the compound stimuli would be processed as a whole and perhaps some of the memory effects were lost as a consequence of separating the words from the faces in the current study. A future investigation that involves presenting the faces and words during the recognition memory phase would enable this to be established. A further element of the current study that requires consideration is the critical "lures" used to assess false recognition. In traditional studies addressing false recognition, lure words are non-presented associates of the sets of presented words. These lures are identified by presenting words to participants and asking them to provide as many associated words as they can. This procedure enables those words that are most regularly associated with a given lure word to be identified. These words can then be presented during the encoding phase. However, it should be noted that it was not possible to follow that procedure during the current study. The investigation of false recognition was not the primary focus of the current study and the decision to conduct this part of the study was taken after the initial tasks (selective attention & recognition memory) had been developed. Therefore, the choice of critical "lures" was restricted to the non-presented words that were already included as distracters in the recognition memory study. Whilst the depression-relevant lures were very representative of the words presented at encoding (see appendices III & IV) the positive "lures" were less

closely associated with the previously presented positive words. This is an obvious limitation of the current study. It would be appropriate to conduct a pilot study prior to any future investigations of false recognition in depression in order to obtain reliable participant agreement concerning appropriate positive and negative associates to be used as critical lures. However, it is still the case that the groups differed on the (highly suitable) depression-relevant lures in the current study and not on the (less suitable) positive lures.

3.5.3. *Summary and Conclusions*

Contrary to predictions, the depressed patients did not demonstrate an attentional bias for sad facial expressions. Conversely, the controls demonstrated an attention bias for happy facial expressions. Depressed individuals exhibited greater difficulty in inhibiting the distracting faces, evidenced by slowed valence identification times in cases that involved incongruent face/word pairs. It would seem feasible that this deficit related to impaired anterior cingulate function in the depressed patients. Also contrary to predictions, the patients did not demonstrate superior memory for negative words. However, there was some evidence of a memory advantage for positive words exhibited by the controls. The predicted effect of face valence on the participants' memory for the words was not observed. The clearest interpretation of the findings is that the presence of the faces at encoding reduced the capacity of cognitive resources that could be applied by the depressed patients to elaboratively encode the words. Finally, depressed patients exhibited a tendency to falsely recognise the depression-relevant "lures". It is clear that the observed findings could have implications for the depressed individuals in terms of social interactions with others and in terms of their ongoing mood. The lack of positive bias attention bias, the superior identification of

negative material, and the tendency towards retrieval of false negative memories could all colour the depressed individual's interpretation of social interactions in which they are involved, and could conceivably contribute to a worsening of the current episode.

-CHAPTER FOUR-

AUTOBIOGRAPHICAL MEMORY IN MAJOR DEPRESSION: DIFFERENT RESPONSES TO VERBAL AND VISUAL EMOTIONAL CUES?

4.1. Introduction

4.1.1. Depression and Autobiographical Memory

There is considerable evidence that, relative to healthy individuals, depressed patients exhibit marked changes in autobiographical memory function (see section 1.4.1.1, page 17). They tend to demonstrate superior access to negative than positive autobiographical memories (ABMs), usually as a consequence of impaired access to positive memories, relative to healthy participants. In addition to differences in the relative access of positive and negative memories, numerous studies (e.g. Kuyken & Brewin, 1995; Williams & Dritschel, 1988) have reported that, when requested to retrieve memories of specific autobiographical events, depressed individuals are more likely than healthy participants to retrieve general categorical memories (see section 1.4.1.1, page 17).

An account of overgeneral ABM retrieval in depression requires an understanding of the organisation of autobiographical knowledge in memory. There is good evidence that ABM knowledge is stored within a hierarchy with information of differing specificity nested at different levels of the hierarchy. Furthermore, this evidence suggests that the information stored in this hierarchy is accessed via a retrieval mechanism that is mediated by the central executive (see section 1.4.1.1, page 17). Whilst healthy individuals are able to move smoothly through the hierarchy to access

the required specificity of autobiographical information, depressed individuals (as noted above) appear to exhibit problems in moving beyond general descriptions.

It has been suggested (e.g. Williams & Dritschel, 1988) that depressed individuals might adopt this retrieval style in order to avoid the painful consequences of accessing specific memories of negative events from their past (see section 1.4.1.1, page 17 for supportive evidence of this proposal). It is proposed that, during ABM retrieval, once the search begins to access elements of emotional events depressed individuals strategically terminate the memory search, which results in the retrieval mechanism making another attempt at retrieving a specific ABM. It is likely that the patients will also terminate the subsequent memory search at the intermediate stage of the hierarchy. According to Williams (1996), a consequence of these repeated attempts to access specific event memories is a network of chronically activated, mainly negative, general memory descriptions. Due to the associations that develop between these general memories, future attempts to access specific ABMs will be more likely to activate this network of general descriptions; Williams (1996) termed this 'Mnemonic Interlock' (see section 1.4.1.1, page 17 for more detailed coverage of this process). Furthermore he suggested that this process is encouraged by, and is encouraging of ruminative self-focus. In line with this there have been a number of studies (e.g. Watkins, 2000) demonstrating that preventing rumination, using a distraction manipulation, is associated with a reduction in overgeneral ABM retrieval.

4.1.2. Cueing Autobiographical Memories

Traditionally, studies addressing ABM retrieval in major depression (e.g. Clark & Teasdale, 1982; Williams & Broadbent, 1986; Williams & Scott, 1988) have utilised the single word cueing task, i.e. participants are required to produce personal

memories in response to single words (e.g. "happy"). Other researchers have utilised modified versions of the verbal cueing task in order to establish if it were possible to modify the overgeneral ABM retrieval associated with depression. Williams & Dritschel (1988), for example, provided additional contextual information in the form of supplementary activity cues (e.g. "*going for a walk*"). However, they reported that this procedure did not lead to the retrieval of more specific ABMs in depressed patients. Moore, Watts & Williams (1988) reported a similar result when they used vignettes (e.g. "*a neighbour helped me with a practical problem*") to cue autobiographical memories.

Despite these findings, there have been a small number of studies demonstrating that it is possible to manipulate the specificity of ABM retrieval. For example, Williams, Healy and Ellis (1999) reported that highly imageable word cues (i.e. words that easily enable an individual to generate an internal image; e.g. *library*) led to greater specificity of ABM retrieval than did less imageable cues (e.g. *boredom*). Subsequently, they demonstrated the superiority of visual imagery in providing access to specific event memories relative to other imagery modalities (auditory, tactile, olfactory and motor). Williams et al (1999) explained this superiority by suggesting that visual images represent a rich source of information concerning a depicted event, as they lead to activation of other related events and concepts. Furthermore, they proposed that visual images provide the most efficient form of summarising available information that can be used by the retrieval processes to search the memory store, and to evaluate potential episodes in terms of task specifications. These findings demonstrate a clear advantage for the visual modality in the retrieval of specific ABMs.

Given the superiority for visual imagery in the retrieval of specific ABMs the next logical step would seem to be to establish the pattern of ABM retrieval that is associated with actual images (e.g. photographs) as opposed to images that are generated internally by the participant. However, work conducted to date has remained focused on the use of verbal stimuli to cue memories. There are good grounds to expect that, compared to the traditional verbal stimuli, non-verbal visual cues might result in a different pattern of ABM retrieval.

First, consider an everyday example of looking at a photograph taken on a previous holiday; it is clear that such an occurrence would lead to recollection of events that occurred around the time that it was taken. Moreover, it would seem likely that, in common with internally generated images, externally perceived pictorial stimuli would provide equally efficient summaries of information that could be used by the retrieval mechanisms to search the autobiographical memory store and to evaluate the suitability of candidate episodes.

Evidence to support this notion comes from Teasdale and Barnard's influential *Interacting Cognitive Subsystems (ICS)* model of cognition and emotion (1993). According to the ICS model, both internally generated images, and perceived objects/events in the real world are represented in the same subsystem (OBJECT) of the cognitive structure, which supports the notion the two experiences are related (Teasdale & Barnard, 1993). Further support for this view comes from a series of studies conducted by Dewhurst and Conway (1994), who demonstrated a similar advantage in recognition memory performance for pictures compared to words, as for high versus low-imageable words. All of which supports the expectation that

externally viewed pictorial stimuli would provide similarly enhanced access to specific autobiographical memories as is provided by internally generated visual images.

From the above, it would seem clear that investigation of the different patterns of ABM retrieval that are associated with visual and verbal cues would represent an interesting and important addition to the existing literature. Furthermore, in light of the findings concerning ABM retrieval in patients suffering from major depression, another important element of such a study would be to establish the extent to which, relative to traditional word cues, visual cues influenced the specificity of ABM retrieval exhibited by a sample of clinically depressed patients. The aim of the current study is to address both of these issues.

4.1.3. The Visually Cued ABM Test

A primary concern, in terms of the development of the proposed visually cued autobiographical memory test, was the type of visual stimuli to be presented to the participants in order to elicit retrieval of personal memories. In traditional cueing tasks (e.g. Williams & Dritschel, 1988; Williams & Scott, 1988) the words have tended to describe either distinct emotions (e.g. *happiness, surprise, anger*) or concepts (mood-congruent & mood-incongruent) that are highly salient to people suffering from depression (e.g. *lonely, successful*). Emotional facial expressions could be considered to be the visual equivalent of the first type of word cue (i.e. they represent distinct emotions). Furthermore, photographic images depicting emotional scenes and social interactions could be considered suitable to represent concepts that would be salient to a person suffering from depression. Evidence supporting this

notion comes from a study conducted by Lang, Greenwald, Bradley and Hamm (1993), who argued that, although individuals are able to make the psychological distinction between pictures and reality, the information contained within pictorial stimuli corresponds with the properties of "real life" objects and events, and as such lead to activation of cognitive representations that are associated with powerful affective reactions.

4.1.4. Major Depression and the Visually Cued ABM Test

As noted above, Williams and Dritschel (1988) suggested that depressed individuals might use the overgeneral retrieval style in order to avoid the negative consequences of accessing specific negative memories. However, as noted by Williams, Teasdale, Segal and Soulsby (2000), it is possible that the cognitive effort required to suppress these memories reduces the amount of available resources that can be utilised to move from general to specific memories.

If overgeneral ABM retrieval does represent a strategic avoidance of the emotive nature of specific memories, then one possible influence on the specificity of ABM retrieval in depressed individuals might be the ease with which the different forms of stimuli (*verbal & visual*) are able to access emotional reactions. It would be expected that cues that lead to greater access of emotional content would be more likely to result in the strategic avoidance of specific retrieval. Therefore, based on the proposal of Williams et al (1997) that pictorial representations are more emotive than verbal descriptions, it would be expected that depressed individuals would demonstrate greater overgeneral retrieval to image cues than to words. Furthermore, as emotional facial expressions are by their nature emotive (see Lundqvist & Dimberg, 1995; Wild,

Erb & Bartels, 2001 for evidence of emotional contagion from faces) it might also be expected that, relative to word cues, emotional faces would result in the retrieval of a greater proportion of generic ABMs by the depressed patients. However, if overgeneral categorical retrieval does represent strategic avoidance of negative affect, on the part of the patients, then it would be expected that any observed increase in generic retrieval would be restricted to negative memories.

Differences in the emotive properties of the distinct forms of stimuli might also be expected to modify other aspects of autobiographical retrieval that are influenced by the valence of the memory cues, namely retrieval times and proportion of positive and negative memories retrieved. Teasdale and Barnard (1993) proposed that, according to their ICS model, different elements of a given event (e.g. visual, spatial, emotional, etc) are represented in multiple subsystems within the cognitive architecture. In line with Williams (1996), Teasdale and Barnard (1993) suggest that ABM retrieval requires constructing a "description" or summary of the required information with which to access these stored representations. They further suggested that mood congruent retrieval of autobiographical memories depends upon the mood at recall enhancing the availability of descriptions relating to material of a similar emotional tone. In particular they noted the importance of the distinction between "hot" and "cold" cognition in explaining mood-congruent memory. In terms of personal memory retrieval, "cold" cognition refers to the access of elements of a given event (e.g. its semantic meaning) without a re-experience of the relevant emotional reactions. In contrast "hot" cognition reflects the affective representation of the event, and hence will be accompanied by the appropriate emotional response. According to Teasdale and Barnard (1993) the presence of mood-congruent retrieval bias requires

access to representations in the Implicational sub-system, as (in the *ICS* model) this is the sub-system that represents affect-related “hot” themes from an individual’s past. With this in mind, it would be expected that memory cues that lead to greater access of emotional representations (i.e. Implicational representations) would result in stronger mood congruent effects. Therefore, based on the assumption that images and faces are more emotive than words, and presumably would be more likely to access the Implicational code, it would be expected that mood-congruent retrieval effects would be stronger for the visual stimuli than for word cues.

4.1.5. Overview and Predictions

Clinically depressed patients and healthy controls were presented with three different sets of affective memory cues (*words, faces & images*) and were asked to retrieve, as quickly as they could, a specific autobiographical memory (ABM) in response to each cue. The cues were presented in blocks (e.g. all words together etc). Participants were also asked to rate the pleasantness of each ABM they retrieved. The following predictions were made:

1. In line with Williams et al (1999) it was expected that images would lead to greater access to specific ABMs than would words or faces. With this in mind it was predicted that participants would be significantly faster to retrieve specific ABMs to images than to words or faces. However, in line with Williams and Dritschel (1988) it was predicted that depressed individuals would not demonstrate enhanced retrieval to images, therefore no differences were expected for the depressed individuals retrieval times to the different memory cues.

2. In line with previous findings (outlined in section 1.4.1.1, page 17) it was predicted that depressed patients would be significantly faster to produce negative than positive memories. Conversely, it was expected that the controls would be faster to produce positive than negative memories.
3. In line with Williams et al (1999), it was expected that, overall, participants would retrieve significantly more specific ABMs (as a first response) when cued with images than when cued with words or faces. However, it was not expected that depressed individuals would demonstrate this specificity advantage for the image cues.
4. In line with previous findings (outlined in section 1.4.1.1, page 17) it was expected that depressed patients would retrieve significantly fewer specific ABMs than would the controls. However, in line with previous findings it was also expected that depressed individuals would retrieve significantly fewer specific positive than negative ABMs.
5. Based on previous findings (outlined in section 1.4.1.1, page 17) it was expected that depressed individuals would make significantly more categorical retrieval errors than either omissions or extended errors. Furthermore, it was expected that depressed participants would retrieve significantly more categorical memories than would the controls.

4.2. Method

4.2.1. Design

This study utilised a 2 between (group) x 3 within (cue type) x 2 within (memory valence) mixed factorial design. The independent variables were the type of affective stimuli used to cue the ABMs (*words, images & faces*) and the valence of the

retrieved ABMs (*positive or negative*; identified post-hoc based on the participants' own ratings of the pleasantness of the retrieved memories). The dependent variables were time taken (in seconds) to retrieve a specific ABM, the number of positive and negative ABMs retrieved, the percentage of specific ABMs retrieved as a first response to the cues and the number of each type of retrieval error (*extended, categorical & omissions*). The three types of stimuli (words, images & faces) were presented in blocks (i.e. all faces in one block, all images in another block & all words in a final block). The order in which the participants completed the three blocks of stimuli was counterbalanced using the Latin squares technique.

4.2.2. Participants

25 clinically depressed patients (15 females, 10 males) and 25 healthy controls (16 females, 9 males) took part in the current study. According to Cohen (1992) this sample size is suitable to detect the large effect sizes that were predicted in the current study based on previous studies (e.g. Williams & Scott, 1988) addressing ABM retrieval in depressed patients (see appendix II for full details of this power analysis). The participants were recruited according to the inclusion and exclusion criteria cited in chapter two (section 2.6.3, page 55). Furthermore, upon admission to the study they were assessed according to the standard protocol outlined in chapter two (section 2.6.2, page 54). The characteristics of the individuals making up the two participant groups are reported in table 4.1 (page, 118). The two groups were matched in terms of age, sex, educational background, and pre-morbid intellectual ability. Prior to their participation in the study, the severity of the patients' depression was quantified by one of the psychiatrists at the Affective Disorders Clinic according to the 17-item

Hamilton Rating Scale for Depression (HRSD; Hamilton, 1961). The mean HRSD score for the patients in the current study was 20.6 (with a range of 14 – 27).

4.2.3. Materials and Apparatus

4.2.3.1. Emotional Words

Ten emotional words (5 positively valenced, 5 negatively valenced) that had been used in previous studies addressing autobiographical memory retrieval in psychiatric patients (e.g. Williams and Broadbent, 1986) were used in the current study to cue autobiographical memories. The five positive cues were “*Happy*”, “*Interested*”, “*Safe*”, “*Successful*” and “*Surprised*” and the five negative cues were “*Clumsy*”, “*Angry*”, “*Hurt*” (emotionally), “*Lonely*” and “*Sorry*”. Two neutral words (“*Bus*” and “*Table*”) were included as practice items.

4.2.3.2. Emotional Images

Ten emotional images (5 positively valenced, 5 negatively valenced), drawn from the International Affective Picture System (*IAPS* - Lang, Bradley & Cuthbert, 1997), were used during the current study to cue autobiographical memories. *IAPS* is a collection of photographic images of different emotional scenes that have been rated by 300 participants in terms of their affective valence on a 9-point scale (1=*extremely unpleasant/negative*, 5= *neutral* & 9=*extremely pleasant/positive*). The participants also rated how arousing the images were on a 9-point scale (1=*not arousing* and 9=*extremely arousing*). The images incorporated in the current study were matched in terms of their arousal ratings (*positive* $\mu=4.7$, $SD=0.8$; *negative* $\mu=4.5$, $SD=0.7$); $t(8)=0.5$, $p>0.05$. However, as expected the two sets of images differed significantly in terms of their valence ratings (*positive* $\mu=7.4$, $SD=0.3$; *negative* $\mu=3.3$, $SD=0.8$);

$t(8)=10.6, p<0.05$. The positive images (see appendix XI) presented during the study were *"A loving couple" (male with female)*, *"A family group" (mother, father & young child)*, *"Granddad fishing with grandchild"*, *"a very happy woman on a sunny day, pouring water over her head"* and *"a group of teenage friends having fun at the beach"*. The negative images (see appendix XII) presented during the study were *"a couple arguing/fighting" (male upon female)*, *"a young boy crying"*, *"mourners at a funeral"*, *"a boy failing a maths problem in front of his classmates"* and *"a child curled up in the foetal position looking scared"*. Two neutral images (see appendix XI) were also included as practice items these were *"a man playing a guitar"* and *"a shadow of someone cast onto a road"*. The images were chosen by the author to represent themes/events that the participants were likely to have experienced. The suitability of the chosen stimuli was established in consultation with a second researcher (BD).

4.2.3.3. Emotional Facial Expressions

Eight grey-scale photographic images of different individuals portraying either happiness or sadness (four of each) were used during the current study to cue autobiographical memories (see appendix XIII). A young male and young female (in their mid twenties), and an older female and older male (late forties – early fifties) portrayed each expression. The faces were drawn from a set used in a study looking at emotion processing in healthy adults (Le Gal & Bruce, 1999). 70 undergraduate students (35 male, 35 female) rated the faces in terms of what emotion they considered each face to be displaying (a forced choice paradigm was employed in their study). The faces used in the current study all achieved over 75% subjective

agreement concerning the emotion portrayed. Two neutral faces (one male, one female) were also included as practice items.

4.2.3.4. Stimulus Presentation

During all three autobiographical memory tasks, an AppleMac PowerBook 3004 laptop computer loaded with the Superlab[®] program Version 1.5.7 (Cedrus Corporation, 1992, Phoenix, Arizona) was used to present the stimuli to the participants one at a time (in a random order).

4.2.3.5. Response Measurement

A stopwatch was used to record the time taken by the participants to retrieve specific autobiographical memories. A Sony audiocassette recorder (with an external microphone) was used to record the details of the memories retrieved by the participants to the different cues. Printed record sheets were also used to document the central details of the memories, to note the retrieval times for each memory, and to record the pleasantness rating (see below) assigned by the participants to each memory they retrieved.

4.2.3.6. Pleasantness Rating

A five-point pleasantness rating scale was printed in 36-point bold type on an A4 sheet. The scale was anchored at one end (nearest the one) with the words *extremely unpleasant* and at the other end (nearest the five) with the words *extremely pleasant*. The scale was designed to allow the participants to rate the memories they retrieved in terms of how pleasant or unpleasant they considered them to be.

4.2.4. Procedure

The procedure was identical for all three of the autobiographical memory tests. The participants were presented with memory cues (either *words*, *images* or *faces*) one at a time via the computer screen, and were asked to retrieve a specific memory of an event from their past that each cue brought to mind. A specific memory was defined as *"a memory of an event that occurred at a specific time and place, and that lasted less than a day"*. Examples of specific memories were given in the instructions prior to all three ABM tests, e.g. *"in response to the cue word **Boat**, you might retrieve a memory of a ferry trip you took to France when you were at school, rather than I used to play with toy boats when I was a kid"*. The participants were not restricted in terms of the period of their lives from which they could recall memories. Furthermore, they were instructed that the events they retrieved could be trivial or important. Once a cue had appeared on the screen it remained in view of the participant until they retrieved a memory. If the participant failed to retrieve a memory within 30 seconds then it was coded as an omission and the next cue was presented. However, if the participants indicated that they had retrieved a memory (by saying "Yes" or "OK") then the experimenter stopped the stopwatch, noted the time and recorded the basic details of the memory (on audiotape and in writing on the response sheet). If the participant had retrieved a specific ABM they were asked to rate the memory in terms of how pleasant they considered it to be (using the rating scale provided). However, if the memory they had retrieved was not specific the experimenter prompted them with *"Can you give me a specific example – one single event?"* The stopwatch was restarted and timing continued until the participant retrieved a specific memory. This process was repeated until a specific memory was retrieved or until the time on the stopwatch reached 30 seconds. Prior to each of the three ABM tests the participants

were presented with a summary of the instructions and two practice stimuli in order to ensure that they understood their task. The participants were also instructed to provide a different memory for each cue (*word, face or image*) that they viewed during the study. Once all three ABM tests had been completed the participants were required to rate their recent mood on the 21-item BDI and the HADS. Finally, they were asked to complete the NART.

4.2.5. Coding of retrieved ABMs

The memories that were retrieved by the participants as a first response to each cue were coded as one of three types of autobiographical memory. Specific ABMs referred to unique events that lasted less than one day (e.g. *"going to see a rock band last weekend"*), extended ABMs referred to particular time periods that lasted longer than a day (e.g. *"my holiday in the south of France two summers ago"*) and categorical ABMs referred to summaries of events (e.g. *"going for a coffee with friends"*). Failures to retrieve memories to cues within 30 seconds were coded as omissions. The author (NR) coded all memories retrieved by the participants as a first response. However, a second rater (BD) who was blind to participants' group membership rated all of the memories from a sample of twenty participants (10 patients, 10 controls). The mean inter-rater agreement was 85% (see appendix XIV for full details of this analysis).

4.2.6. Data Analysis

A MANOVA was conducted in order to establish if there were any significant differences between the two groups in terms of age, educational background (years of full-time education completed), intellectual ability (full-scale IQ score estimated from

the number of reading errors on the NART) and scores on the self-report measures of depression and anxiety. A chi-squared test was utilised to establish if the two groups differed in terms of the number of males and females making up each group. The time taken (in seconds) to retrieve specific ABMs, the percentage of specific ABMs retrieved as a first response and the number of positive and negative ABMs retrieved were analysed using 2 (group) x 3 (cue type) x 2 (memory valence) repeated measures ANOVA. The number of each type of retrieval errors committed by the participants was analysed using a 2 (group) x 3 (cue type) x 3 (error type) repeated measures ANOVA. Subsequent pair-wise comparisons were conducted using Least Significant Difference tests when a-priori predictions had been made and Bonferroni tests where no predictions had been made. Follow up analyses of significant interactions were conducted using one-way and two-way factorial ANOVA, and paired and independent t-tests. The alpha level of these tests was adjusted where appropriate, to control for multiple comparisons, using Holm's Sequential Bonferroni Correction Method (Green & Salkind, 2003). Initial inspection of the responses to the memory cues revealed that two of the images (*kids playing on a beach & happy girl on a sunny day*) had consistently led to memories of holidays or going on holiday. This finding was observed in both patients (*56% of the sample*) and controls (*40% of the sample*). These memories were almost exclusively extended (*e.g. my holiday in Spain last year*) or categorical (*e.g. I used to go on holidays with my family*). It was considered likely that the tendency of the participants to produce general memories to these two cues could have obscured evidence of increased specificity to images; therefore participants' responses to these cues were removed from the data set prior to the main analysis.

4.3. Results

4.3.1. Participant Characteristics

Analysis of the data presented in table 4.1 revealed that the two groups were well matched in terms of age; $F<1$, Sex, $\chi^2(1)=0.09$, $p>0.05$; educational background [$F<1$], and pre-morbid intellectual ability [$F<1$]. Although the estimated IQ of the two groups did not differ significantly, the observed IQ scores for both groups were relatively high, which suggests there may have been a sampling bias, such that patients with higher IQ may have been more likely to agree to participate or the clinicians may have considered these patients as more suitable for the current study.

Table 4.1. Characteristics of the individuals in the two participant groups

	Depressed (N=25)	Controls (N=25)	P-Value
Age	42.7 (2.0)	41 (2.1)	NS
Sex	15 female	16 female	NS
Years of FTE	12.6 (0.6)	12.6 (0.6)	NS
IQ (Estimated)	113 (7.4)	114 (5.8)	NS
BDI	28.9 (1.9)	3.8 (0.6)	<0.0001
HADS_A	13.6 (0.7)	4.4 (0.7)	<0.0001
HADS_D	12.6 (0.7)	1.6 (0.4)	<0.0001

FTE=full-time education, BDI=Beck Depression Inventory, HADS_A=Hospital Anxiety and Depression Scale – Anxiety Scale, HADS_D=Hospital Anxiety and Depression Scale – Depression Scale.

As expected the patients rated themselves a significantly more depressed than did the controls on the BDI; $F(1, 48)=159, p<0.0001$ and the HADS depression subscale; $F(1, 48)=184, p<0.0001$. Also as expected, the patients rated themselves as significantly more anxious than did the controls on the HADS anxiety subscale, $F(1, 48)=84.1, p<0.0001$. Analysis of the relative contribution of depression and anxiety in explaining the ABM retrieval effects reported in this chapter revealed that it was consistently depression and not anxiety that accounted for these effects (see appendix XV for full coverage of these analyses).

4.3.2. ABM Retrieval Times

In line with Williams et al (1999) it was expected that images would lead to greater access to specific ABMs than would words or faces. With this in mind it was predicted that participants would be significantly faster to retrieve specific ABMs to images than to words or faces. However, in line with Williams and Dritschel (1988) it was also predicted that depressed individuals would not demonstrate enhanced retrieval to images, therefore no differences were expected for the depressed individuals' retrieval times to the different memory cues.

Analysis of the participants' retrieval times (presented in table 4.2) revealed that, overall, depressed patients were significantly slower ($\mu=10$ seconds, $SE=1.0$) to retrieve specific ABMs than were the controls ($\mu=7.5$ seconds, $SE=0.4$); $f(1, 48)=5.6, p<0.05$. Furthermore, there was a significant main effect of cue type on the participants' retrieval times; $f(2, 96)=11.7, p<0.001$. Overall, participants were significantly slower to faces ($\mu=9.9s, SE=0.7$) than to images ($\mu=8.1s, SE=0.6$) or words ($\mu=8.2s, SE=0.5$); $p<0.001$ and $p<0.01$ respectively.

Table 4.2. Mean time (seconds) taken by the participants to retrieve specific ABMs in response to the different types of affective cues, as a function of the valence of the ABM retrieved (Standard errors presented in parentheses).

Type of Cue	Valence of ABM retrieved	Depressed (N=25)	Controls (N=25)
Words	Positive	9.7 (1.0)	6.7 (0.5)
	Negative	8.3 (0.9)	8.3 (0.8)
Images	Positive	9.9 (1.1)	5.5 (0.5)
	Negative	8.9 (1.1)	7.9 (0.5)
Faces	Positive	11.4 (1.3)	7.3 (0.7)
	Negative	11.4 (1.4)	9.3 (0.8)

However, analysis of the participants' retrieval times also revealed some evidence of a group x cue type interaction (illustrated in figure 4.1); $f(2, 96)=2.4$, $p=0.09$.

Subsequent analysis of these data revealed that depressed individuals were significantly slower to retrieve ABMs to faces ($\mu=11.6s$, $SE=1.2$) than to words ($\mu=8.9s$, $SE=0.9$) or images ($\mu=9.4s$, $SE=1.0$); $t(24)=3.4$; $p<0.01$ and $t(24)=3.3$, $p<0.01$ respectively. There was no difference in the depressed individuals retrieval times for words and images, $t(24)=1.0$, $p>0.05$. The participants in the control group were also significantly slower to retrieve specific ABMs to faces ($\mu=8.3s$, $SE=0.5$) than to images ($\mu=6.7s$, $SE=0.4$), $t(24)=3$, $p<0.001$. However, there was no significant difference between the controls retrieval times to faces and words ($\mu=7.5s$, $SE=0.5$); $t(24)=1.5$, $p>0.05$. Similarly, there was no significant difference between the controls retrieval times for images and words, $t(24)=1.2$, $p>0.05$.

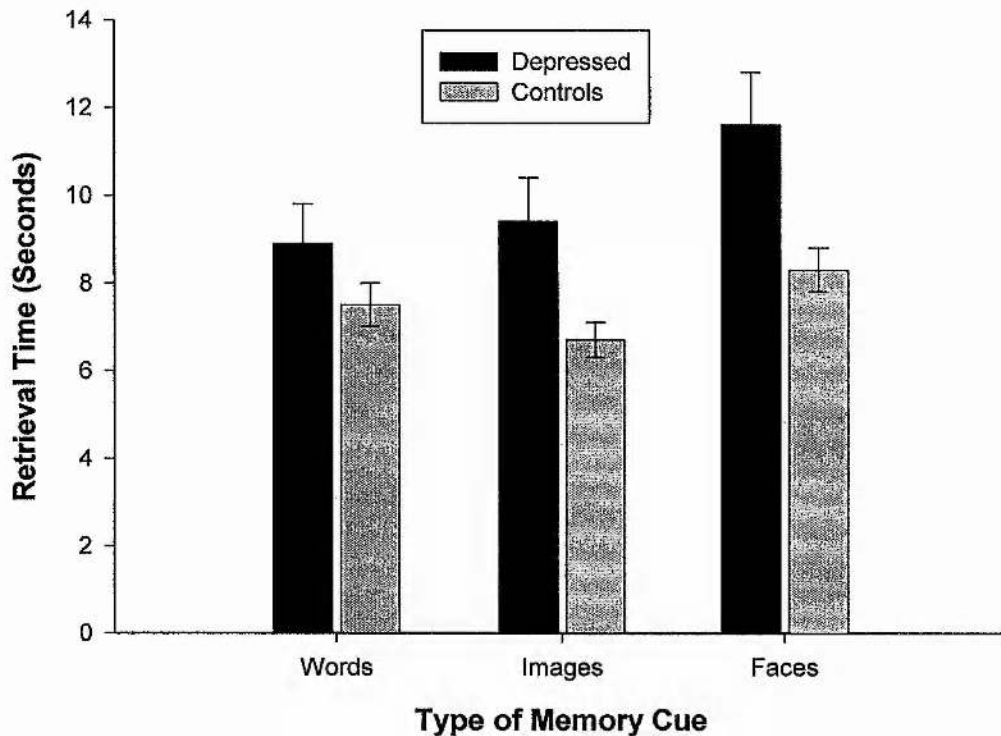


Figure 4.1. Mean time (in seconds) taken by the participants to retrieve a specific ABM, as a function of type of memory cue (error bars represent \pm one standard error of the mean)

Further analysis of the participants' retrieval times to the different cue types revealed that depressed individuals were significantly slower ($\mu=9.4s$, $SE=1.0$) than the controls ($\mu=6.7s$, $SE=0.4$) to retrieve specific memories when cued with images; $t(48)=2.5$, $p<0.05$. Similarly, depressed individuals were slower ($\mu=8.1s$, $SE=0.6$) than the controls ($\mu=8.1s$, $SE=0.6$) to retrieve specific ABMs when cued with faces; $t(48)=2.4$, $p<0.05$. However, the two groups did not differ in their retrieval times to word cues (depressed $\mu=8.9s$, $SE=0.9$; controls $\mu=7.5s$, $SE=0.5$); $t(48)=1.4$, $p>0.05$.

The main analysis of the participants' ABM retrieval times also revealed a highly significant group x valence interaction (illustrated in figure 4.2); $F(1, 48)=17.9$, $p<0.001$.

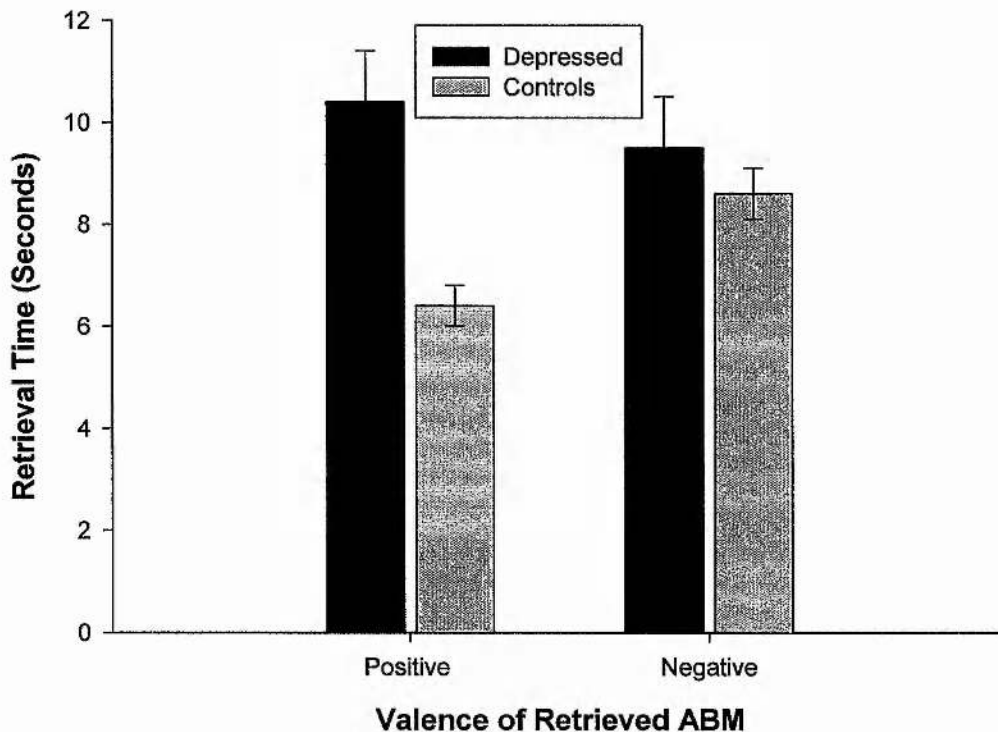


Figure 4.2. Mean time in seconds taken by the participants to retrieve positive and negative ABMs (error bars represent \pm one standard error of the mean)

Subsequent analysis of these data revealed that depressed individuals were significantly slower ($\mu=10.4s$, $SE=1.0$) than the controls ($\mu=6.4s$, $SE=0.4$) to retrieve positive ABMs; $t(48)=3.7$, $p<0.001$. However, the two groups did not differ significantly in terms of their retrieval times for negative ABMs (depressed $\mu=9.5s$, $SE=1.0$; controls $\mu=8.6s$, $SE=0.5$); $t(48)=1.0$, $p>0.05$. The depressed individuals were significantly faster to retrieve negative ($\mu=9.5s$, $SE=1.0$) than positive ABMs ($\mu=10.4s$, $SE=1.0$); $t(24)=1.7$, $p<0.05$ (one-tailed). Conversely, the controls were

significantly faster to retrieve positive ($\mu=6.4s$, $SE=0.4$) than negative ABMs ($\mu=8.6s$, $SE=0.5$); $t(24)=4.3$, $p<0.001$.

4.3.3. *Specificity of retrieved ABMs*

In line with Williams et al (1999), it was expected that, overall, participants would retrieve significantly more specific ABMs (as a first response) when cued with images than when cued with words or faces. However, it was not expected that depressed individuals would demonstrate this specificity advantage for the image cues.

Table 4.3. Percentage of specific ABMs given by the participants as a first response to the different types of affective cues, as a function of the valence of the ABM retrieved (standard errors presented in parentheses).

Type of Cue	Valence of ABM retrieved	Depressed (N=25)	Controls (N=25)
Words	Positive	67.7 (6.9)	92.6 (2.9)
	Negative	59.3 (7.0)	87.7 (2.9)
Images	Positive	63.6 (6.7)	98.0 (1.4)
	Negative	52.6 (6.8)	95.6 (1.8)
Faces	Positive	50.7 (6.8)	89.2 (4.9)
	Negative	42.3 (6.2)	94.0 (4.4)

Analysis of the percentage of specific ABMs retrieved as a first response revealed a significant effect of cue type; $f(2, 96)=3.5$, $p<0.05$. Subsequent analysis revealed that participants retrieved significantly fewer specific ABMs to faces cues ($\mu=69.1\%$, $SE=4.7$) than to words ($\mu=76.9\%$, $SE=3.9$) or images ($\mu=77.5\%$, $SE=3.9$); $p<0.05$ and

$p < 0.01$ respectively. However, the percentage of specific ABMs retrieved by the participants to words and images did not differ significantly, $p > 0.05$. The main analysis of ABM specificity also revealed a significant group \times cue type interaction (illustrated in figure 4.3); $f(2, 96) = 3.5$, $p < 0.05$.

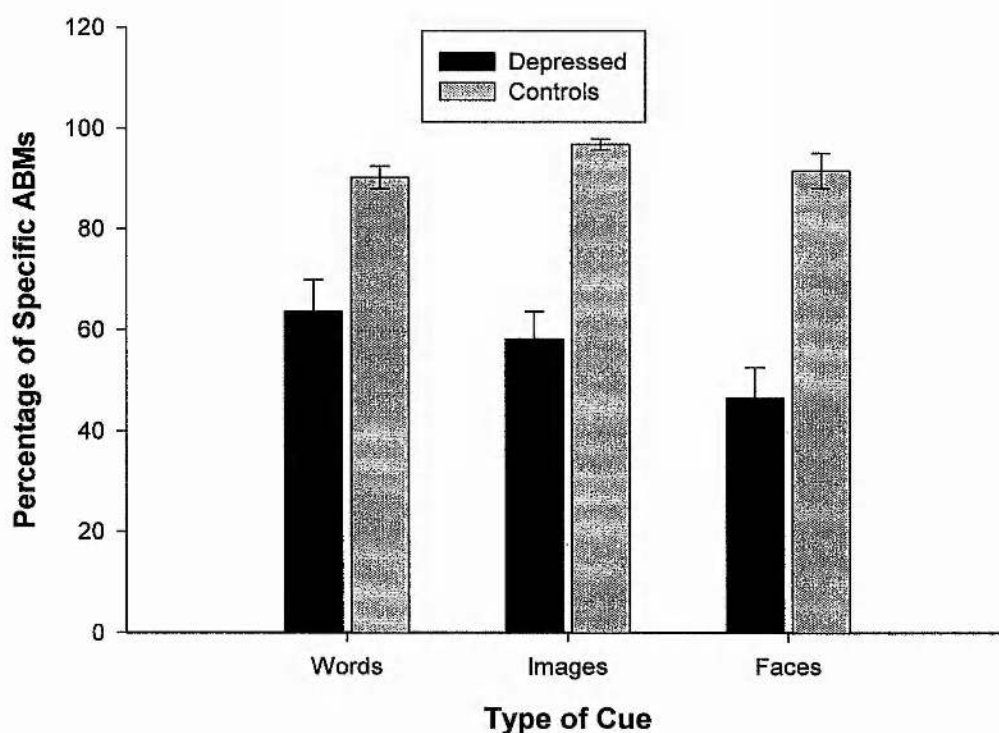


Figure 4.3. Percentage of specific ABM retrieved the different cues, as a function of participant group (error bars represent \pm one standard error of the mean)

Subsequent analysis of these data revealed that healthy controls retrieved significantly more specific ABMs to images ($\mu = 96.8\%$, $SE = 1.1$) than to words ($\mu = 90.2\%$, $SE = 2.3$); $t(24) = 2.3$, $p < 0.05$. Similarly, controls retrieved more specific ABMs to images than to words ($\mu = 91.6\%$, $SE = 3.5$), a difference that approached conventional significance, $t(24) = 1.5$, $p = 0.07$. Interestingly, depressed individuals retrieved significantly fewer specific ABMs to faces ($\mu = 69.1\%$, $SE = 4.7$) than to words

($\mu=76.9\%$, $SE=3.9$), $t(24)=2.8$, $p<0.01$. Similarly, depressed individuals produced fewer specific ABMs to faces than to images ($\mu=77.5\%$, $SE=3.9$), a difference that approached conventional significance, $t(24)=2.0$, $p=0.06$.

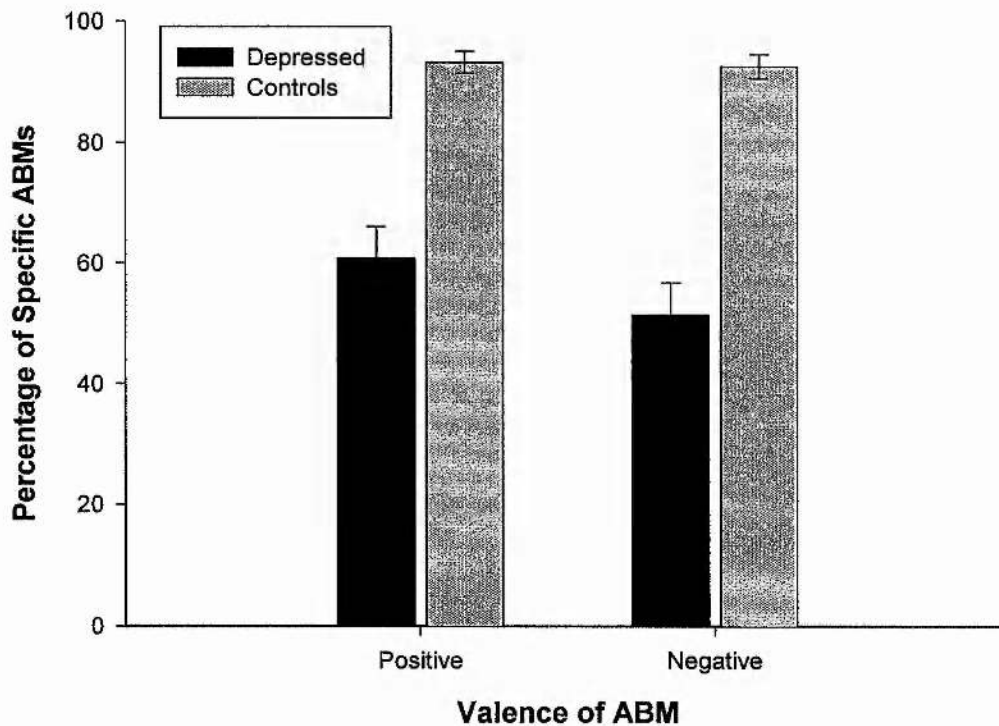


Figure 4.4 Percentage of specific positive and negative ABMs retrieved, as a function of participant group (error bars represent \pm one standard error of the mean)

In line with previous findings (outlined in section 1.4.1.1, page 17) it was expected that depressed patients would retrieve significantly fewer specific ABMs than would the controls. However, in line with previous findings it was also expected that depressed individuals would retrieve significantly fewer specific positive than negative ABMs. In line with this hypothesis, depressed individuals retrieved significantly fewer specific ABMs ($\mu=56.1\%$, $SE=4.9$) as a first response to the

memory cues than did the controls ($\mu=92.9\%$, $SE=4.9$), $f(1, 48)=52.4$, $p<0.001$. However, there was also evidence of a group x valence interaction (illustrated in figure 4.4); $f(1, 48)=3.3$, $p=0.07$. Subsequent analysis of these data revealed that depressed individuals retrieved significantly fewer negative ($\mu=51.4\%$, $SE=5.3$) than positive ABMs ($\mu=60.7\%$, $SE=5.3$); $t(24)=2.4$, $p<0.05$. On the other hand, the number of specific positive ($\mu=93.2\%$, $SE=1.8$) and negative memories ($\mu=92.5\%$, $SE=2.6$) produced by the controls did not differ significantly, $p>0.05$.

4.3.4. Type of Retrieval Errors

Analysis of the number of retrieval errors committed by the participants revealed that, overall, depressed individuals made significantly more retrieval errors ($\mu=1.8$, $SE=0.7$) than did the controls ($\mu=0.7$, $SE=0.5$), $f(1, 48)=46.5$, $p<0.001$. This analysis also revealed a significant main effect of cue type on the number of retrieval errors; $f(2, 96)=11.4$, $p<0.001$. Subsequent analysis of these data revealed that participants made significantly more errors to faces ($\mu=1.5$, $SE=0.1$) than to words ($\mu=1.2$, $SE=0.1$) or images ($\mu=1.1$, $SE=0.1$), $p<0.05$ and $p<0.001$ respectively. However, the number of retrieval errors committed by the participants did not differ significantly for words and images, $p>0.05$. The main analysis of retrieval errors also revealed a significant main effect of error type; $f(2, 96)=44.3$, $p<0.001$. Subsequent analysis of these data revealed that participants made significantly more categorical ($\mu=2.1$, $SE=0.3$) than extended errors ($\mu=0.1$, $SE=0.02$); $p<0.001$. Participants also made more categorical errors than omissions ($\mu=1.6$, $SE=0.3$), a difference that approached conventional significance, $p=0.07$. Furthermore, participants made significantly more omissions than extended errors, $p<0.001$.

Table 4.4. Mean number of each type of retrieval error committed by the participants, as a function of type of memory cue (standard errors are presented in parentheses)

Type of Retrieval Error	Type of Memory Cue	Depressed (N=25)	Controls (N=25)
Omissions	Words	1.8 (0.3)	1.2 (0.2)
	Images	1.5 (0.3)	1.6 (0.2)
	Faces	1.9 (0.3)	2.4 (0.4)
Extended	Words	0.2 (0.1)	0.2 (0.1)
	Images	0.5 (0.1)	0
	Faces	0.1 (0.1)	0
Categorical	Words	3.2 (0.6)	0.8 (0.2)
	Images	3.3 (0.4)	0.5 (0.1)
	Faces	4.3 (0.5)	0.6 (0.2)

Based on previous findings (outlined in section 1.4.1.1, page 17) it was expected that depressed individuals would make significantly more categorical retrieval errors than either omissions or extended errors. Furthermore, it was expected that depressed participants would retrieve significantly more categorical memories than would the controls.

In line with these predictions, analysis of the participants' retrieval errors revealed a significant group x error type interaction (illustrated in figure 4.5); $f(2, 96)=30.2$, $p<0.001$. Subsequent analysis of these data revealed that depressed individuals made significantly more categorical errors ($\mu=3.6$, $SE=0.4$) than extended ($\mu=0.1$, $SE=0.03$)

or omissions ($\mu=1.7$, $SE=0.2$), $t(24)=7.9$, $p<0.001$ and $t(24)=3.7$, $p<0.001$ respectively. Depressed individuals also made significantly more omissions than extended errors; $t(24)=8.5$, $p<0.001$. On the other hand, controls made significantly more omissions ($\mu=1.4$, $SE=0.2$) than extended ($\mu=0.1$, $SE=0.03$) or categorical errors ($\mu=0.6$, $SE=0.1$); $t(24)=6.2$, $p<0.001$ and $t(24)=3.9$, $p<0.001$ respectively. They also made significantly more categorical than extended errors, $t(24)=4.6$, $p<0.001$.

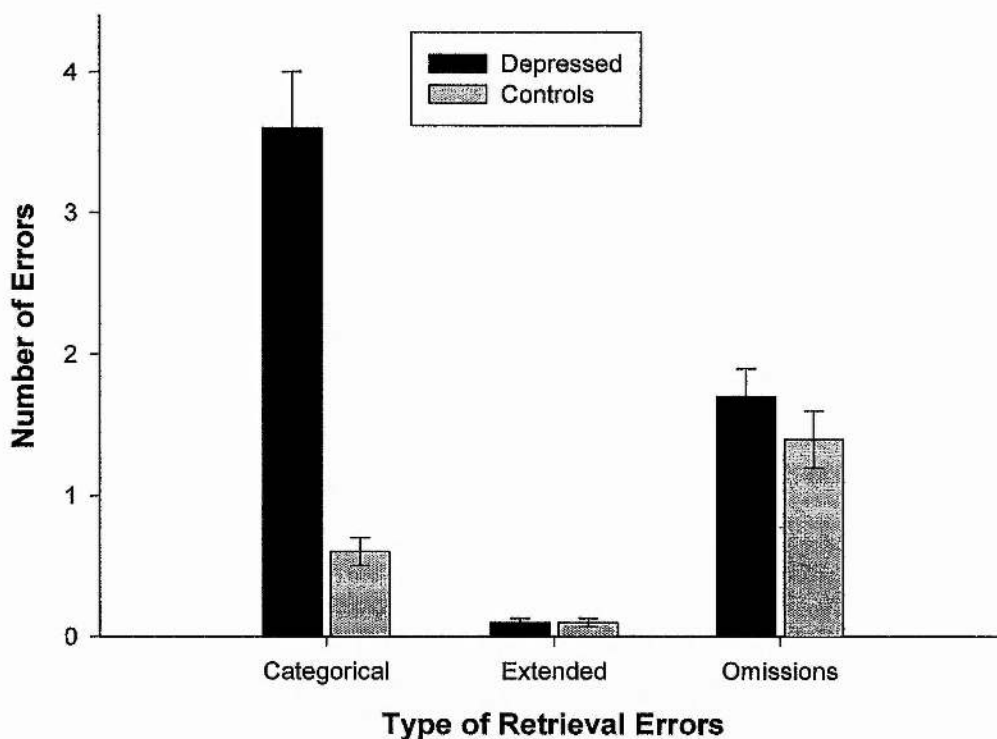


Figure 4.5. Mean number of retrieval errors, as a function of participant group (error bars represent \pm one standard error of the mean)

Further analysis of these data also revealed that depressed individuals made significantly more categorical errors ($\mu=3.6$, $SE=0.4$) than did the controls ($\mu=0.6$, $SE=0.1$); $t(48)=7.1$, $p<0.001$. However, the two groups did not differ in terms of the

number of omissions or extended errors they made; $t(48)=1.0$, $p>0.05$ and $t(48)=1.1$, $p>0.05$ respectively.

The main analysis of the participants' retrieval errors also revealed a significant group x cue type x error type interaction; $f(4, 192)=3.8$, $p<0.05$. In order to elucidate the nature of this interaction the number of omissions, extended and categorical errors committed by the participants were analysed separately using 2 (group) x 3 (cue type) repeated measures ANOVA.

These analyses revealed a significant effect of cue type on the number of omissions; $F(2, 96)=7.2$, $p<0.01$. Overall, participants made more omissions to faces ($\mu=2.1$, $SE=0.3$) than to images ($\mu=1.1$, $SE=0.2$), $p<0.05$. They also made more omissions to faces than to words ($\mu=1.5$, $SE=0.2$), a difference that approached conventional significance, $p=0.09$. There was no difference between words and images in terms of the number of omissions, $p>0.05$. There was no significant main effect of group and no group x cue type interaction, $p>0.05$.

Analysis of the number of extended memories retrieved revealed a significant main effect of cue type; $f(2, 96)=7.5$, $p<0.001$. Overall, participants retrieved significantly more extended memories to words ($\mu=0.2$, $SE=0.1$) than to images ($\mu=0.03$, $SE=0.03$) or faces ($\mu=0.03$, $SE=0.03$), $p<0.01$ and $p<0.01$ respectively. There was no difference between images and faces, $p>0.05$. There was also no significant main effect of group and no group x cue type interaction, $p>0.05$.

Analysis of the number of categorical memories retrieved by the participants revealed no significant main effect of cue type, $f(2, 96)=2.5$, $p>0.05$. However, depressed individuals made significantly more categorical errors than did the controls, $f(1, 48)=44.8$, $p<0.001$. Furthermore, analysis of the number of categorical errors committed by the participants revealed a significant group x cue type interaction (illustrated in figure 4.6); $f(2, 96)=3.1$, $p<0.05$.

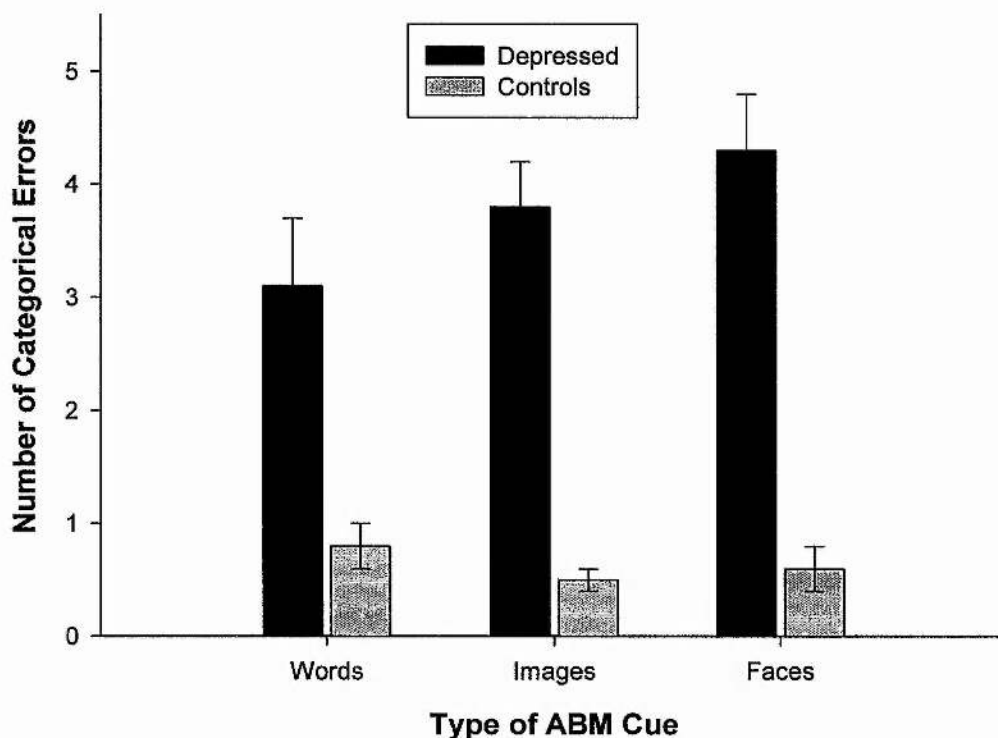


Figure 4.6. Mean number of categorical errors committed by the participants, as a function of cue type (error bars represent \pm one standard error of the mean)

Further analysis of these data revealed that depressed individuals retrieved significantly more categorical memories to faces than to words or images, $t(24)=2.2$, $p<0.05$ and $t(24)=2.6$, $p<0.05$ respectively. The number of categorical memories

retrieved by the depressed patients to words and images did not differ significantly, $t(24)=0.2$, $p>0.05$.

In order to gain insight into why the depressed patients might be demonstrating more categorical retrieval to the faces compared to the other cue types the content of memories was considered. Initial inspection of memory content revealed that the faces appeared to be encouraging the patients to reflect on their condition and the consequences of their condition. For example in response to sad face cues, Participant KH reported *"Just how I feel all the time at the moment - Just now – right at this minute"*; Participant MF produced *"I seem to feel like that all the time"*, Participant QN retrieved *"There are quite a few, as I feel like that a lot"*, *"it is the face I have when I am determined to do something about how I am feeling"* and participant BT reported that *"It's like looking in a mirror"*. Interestingly, participants' responses to happy face cues also provide evidence that these stimuli might be encouraging the participants to focus on their condition and its consequences. For example, Participant KH in response to a picture of a happy male face *"My husband is like that all of the time - except when I am ill"* and in response to a photograph of a smiling woman *"Feeling happy about life in general – I haven't felt like that for a long time"* and Participant MF *"Being happy with my family – that was before I got ill"*.

One interpretation of these responses is that they are an indication that the faces were encouraging the depressed patients to ruminate. Rumination refers to "focusing of one's thoughts on one's current mood, the causes of one's depression and the consequences of one's depressive symptoms" (Wakins & Brown, 2002). Previous studies (e.g. Wakins & Teasdale, 2001) have reported that rumination in depression is

associated with greater levels of categorical retrieval on the traditional autobiographical memory test (Williams & Broadbent, 1986). It is plausible that induced rumination in the depressed individuals in the face condition contributed to the number of categorical memories they produced. In order to investigate this possibility, content analysis was performed on the participants' responses to memory cues. These responses were categorised as either ruminative or non-ruminative based on the following criterion. Ruminative responses were defined as *"responses where the participant focused on their symptoms, the causes of their symptoms and the consequences of these symptoms"*. Two researchers, the author and a senior academic (BD) at the university of St Andrews, conducted the content analysis individually, which allowed inter-rater reliability concerning the relative coding of ruminative and non-ruminative responses to be established. There was significant inter-rater agreement in terms of the categorisation of the responses to words; $r(50)=0.89$, $p<0.001$, images; $r(50)=0.6$, $p<0.05$ and faces; $r(50)=0.87$, $p<0.001$.

The results of the content analysis revealed that the control group made very few ruminative responses to words (0.8%), images (0.5%) or faces (1.3%). Similarly, depressed individuals made very few ruminative responses to images (1.3%). However, the depressed individuals made a notable number of ruminative responses to both words (9.9%) and faces (14.5%) respectively. In order to establish if faces were associated with ruminative responses a chi square test was conducted on the number of ruminative and non-ruminative responses produced by the depressed participants in response to words and faces.

Table 4.5. Number of ruminative and non-ruminative statements produced by the depressed patients in response to words and faces (expected frequencies are presented in parentheses).

	Ruminative	Non-ruminative
Words (N=464)	24 (31.2)	440 (432.8)
Faces (N=458)	37.5 (30.8)	421 (428.2)

Analysis of the data presented in table 4.6 revealed that depressed individuals produced a greater number of ruminative responses to faces than would have been expected and fewer non-ruminative responses than would have been expected. Furthermore, this analysis revealed that the depressed patients retrieved fewer ruminative responses to words than would have been expected and a greater number of non-ruminative responses than would have been expected, $\chi^2(1)=3.6$, $p<0.05$ (one-tailed).

4.4. Discussion

The aim of the current study was to establish if emotional images would produce similar advantage in the retrieval of specific ABMs that was shown for highly imagable words in Williams et al (1999). The study also aimed to establish if the findings of overgeneral categorical retrieval in clinically depressed individuals that has been consistently reported in response to verbal cues (e.g. words) generalised to non-verbal memory cues (images & faces).

4.4.1. ABM Retrieval Times

In line with Williams et al (1999) it was expected that images would lead to greater access to specific ABMs than would words or faces. With this in mind it was predicted that participants would be significantly faster to retrieve specific ABMs to images than to words or faces. However, in line with Williams and Dritschel (1988) it was predicted that depressed individuals would not demonstrate enhanced retrieval to images, therefore no differences were expected for the depressed individuals retrieval times to the different memory cues.

Inspection of the participants' retrieval times revealed that the first part of this hypothesis was not supported as; overall; images did not produce faster retrieval of specific ABMs. Overall, the participants' retrieval times were slower for the faces than the other two stimuli. However, when the retrieval times of the two groups were considered separately there was some evidence that images were leading to faster retrieval to images relative to faces, but not word cues. In general these findings are inconsistent with the findings of Williams et al (1999) who reported faster retrieval of ABMs in response to highly imageable words compared to low imageable words. These findings suggest the images used in the current study were not providing the same type of retrieval advantage as the imageable words from the Williams' study. Inspection of the depressed individuals' retrieval times revealed that they were markedly slower to face cues than words or images. A plausible explanation of the slower retrieval times to faces compared to the other cue types is that the faces might have required greater processing capacity in order to enable access to the required specificity of ABMs.

In line with previous findings (outlined in section 1.4.1.1, page 17) it was predicted that depressed patients would be significantly faster to produce negative than positive memories. Conversely, it was expected that the controls would be faster to produce positive than negative memories.

Inspection of the participants' retrieval times provided support for these predictions as depressed individuals did exhibit faster retrieval of negative than positive ABMs, whereas the controls demonstrated faster retrieval of positive than negative ABMs. Although the depressed individuals were quicker to produce negative than positive memories, comparison of their data with the pattern of ABM retrieval exhibited by the controls suggests that this bias was due to impaired access to positive memories rather than enhanced access to negative ABMs. These findings are consistent with a number of previous findings in the literature (see Williams, 1996).

4.4.2. Specificity of ABM Retrieval

In line with Williams et al (1999), it was expected that, overall, participants would retrieve significantly more specific ABMs (as a first response) when cued with images than when cued with words or faces. However, it was not expected that depressed individuals would demonstrate this specificity advantage for the image cues.

Inspection of the percentage of specific ABMs retrieved by the participants in response to the different cues revealed that, overall, participants retrieved fewer specific memories to faces than words or images, which does not provide support for the prediction above. However, when the percentage of specific memories retrieved to the different cues was analysed separately for the two groups it was revealed that there

was supportive evidence to suggest that healthy participants retrieved more specific memories to images than then other stimuli (it should be noted that this finding was stronger for faces than for words). These findings are somewhat consistent with Williams et al (1999), as they reported that highly imageable words lead to the retrieval of a greater proportion of specific ABMs than did low imageable words. They suggested that the memory advantage for the imageable words is that they provided summaries of the to-be-recalled material that could be used to search for suitable events in memory. It would seem plausible that visual images could have provided a similar advantage for the controls in the current study. It should be noted that the memory advantage for the images in the current study is smaller than that shown for the imageable words in the previous study (Williams et al, 1999). One plausible explanation for this difference is methodological differences between the two studies. Williams et al (1999) presented the words briefly and then removed them from sight, whereas, in contrast, the images (and other stimuli) in the current study were presented via a computer screen and remained in view until the participant retrieved a suitable memory. It would seem likely that this procedure would have required fewer cognitive resources than would the task in the original study, as in the current study, the participants would not have had to maintain a representation of the cue in working memory, thus the advantage of images as 'summaries' of information may not have been as strong in the current study. This could be investigated in future by comparing retrieval to cues that are presented briefly and then removed and cues that are presented for the duration of the memory search.

The failure on the part of the depressed patients to utilise the memory advantage provided by the images is consistent with previous findings (e.g. Williams &

Dritschel, 1988) reporting that adding specific contextual information to the memory cues in order to help with the memory search (e.g. in addition to the word cue 'happy' participants were presented with phrases to add context to the search e.g. 'when out with friends') did not lead to more specific retrieval in depressed patients.

In line with previous findings (outlined in section 1.4.1.1, page 17) it was expected that depressed patients would retrieve significantly fewer specific ABMs than would the controls. However, in line with previous findings it was also expected that depressed individuals would retrieve significantly fewer specific positive than negative ABMs.

Inspection of the percentage of specific ABMs retrieved by the participants to the different types of cue revealed that in line with the prediction depressed individuals produced significantly fewer specific ABMs than did the healthy controls. This finding is consistent with previous findings (e.g. Williams & Scott, 1988; also see Williams, 1996). However, inspection of the percentage of specific ABMs retrieved by the patients does not support the above prediction as the depressed patients exhibited a significant valence effect in the opposite direction to the one that was predicted. Depressed individuals actually retrieved significantly more positive than negative specific ABMs. This finding is noteworthy as previous findings (e.g. Williams & Scott, 1988) suggest that lower proportion of specific positive ABMs is consistent with the impaired retrieval times for positive memories that are often recorded in the literature (see Williams, 1996, and the retrieval time data above).

4.4.3. *Type of Retrieval Errors*

Based on previous findings (outlined in section 1.4.1.1, page 17) it was expected that depressed individuals would make significantly more categorical retrieval errors than either omissions or extended errors. Furthermore, it was expected that depressed participants would retrieve significantly more categorical memories than would the controls.

Inspection of the number of each type of retrieval errors that were committed by the participants in response to the different types of memory cue revealed that in support of the first of the predictions above depressed individuals retrieved more categorical memories than extended or omissions. Furthermore, in support of the second of the predictions made above it was found that depressed individuals retrieved considerably more categorical memories than did the controls. Importantly, the patients and controls did not differ in terms of the number of extended memory retrievals and omissions they committed. These findings are consistent with many previous studies (e.g. Williams & Dritschel, 1992). Interestingly, inspection of the depressed individuals ABM retrieval to the different types of memory cue revealed that they demonstrated significantly higher retrieval of categorical memories to faces than images or words.

Based on initial inspection of the content of participants' memories it was apparent that depressed individuals exhibited a tendency to respond to face cues by focusing on their mood, and the causes and consequences of this mood. It was considered plausible (based on previous findings e.g. Watkins & Teasdale, 2001) that this rumination might contribute to the increase in categorical retrieval exhibited by the

depressed patients in response to face cues. Therefore, in order to investigate the possibility the content of the participants' ABMs were examined in more detail. This process involved categorising the participants' responses as either ruminative (focusing on the individual's mood and the causes and consequences of this mood) or non-ruminative. The results of this analysis provide some support for the rumination explanation as it revealed that depressed individuals produced more ruminative-type statements than would be expected by chance in response to face cues. This finding is consistent with those reported in previous studies suggesting that higher levels of rumination were associated with more categorical ABM retrieval (e.g. Watkins & Teasdale, 2001).

Despite the partial support for the rumination explanation, inspection of the results of the content analysis revealed that the number of ruminative responses was pretty low relative to the non-ruminative, which suggests that although induced rumination might account for some of the increase in categorical retrieval, demonstrated by the depressed individuals in response to the faces, it is unlikely that it provides a complete explanation. There are a number of alternative/additional explanations that are worthy of consideration. The first is that retrieval of ABMs from face cues may have required greater cognitive resources than retrievals in response to words or images. There is some evidence for this proposal as retrieval times were significantly higher for faces than words or images. If it were the case that retrieval to faces required greater cognitive resources, than images or words, then this would explain why the depressed patients and not the controls exhibited the increase in categorical retrieval. There is considerable research (e.g. Ellis & Ashbrook, 1988) to support that depression is associated with reduced cognitive capacity, thus it would have been expected that the

increased cognitive demand of the faces would have disproportionately affected the patients' retrieval relative to the controls. Furthermore, it has been reported in the literature (see Williams, 1996) that the transition from general to specific ABMs requires cognitive resources to inhibit the general descriptions, and to allow the contextual information to be added to the memory search. Thus, if the face stimuli in the current study required high levels of processing capacity then, as a consequence, the depressed patients would have fewer resources to apply to inhibiting the intermediate descriptions.

A further possible explanation of these results concerns the nature of the different memory cues utilised during the current study. Whilst the thematic content of the words and images varied considerably the faces represented a more generic theme. The generic properties of the faces may have encouraged a more generic retrieval style, and might also account for why retrieval to these stimuli appears to have required greater processing resources than the other stimuli. Furthermore, blocking the stimuli by type may have encouraged this generic retrieval style in response to faces. Moreover, as previous literature has demonstrated that depressed individuals find it extremely difficult to switch between mindsets, then it would be expected that the depressed individuals in the current study would have affected disproportionately by these experimental conditions.

4.4.4. Summary and Conclusions

The findings of the current study provide some support for the proposition that the image cues would provide superior access to specific ABMs than would the faces or words. However, this memory advantage was only observed in the healthy controls,

and only in terms of the percentage of specific ABMs they retrieved. There was no strong evidence from the participants' retrieval times. The increase in ABM specificity for images in the control group is consistent with Williams et al (1999) and suggests that externally viewed visual images may provide similar summaries of task relevant information that can be used to search memory for suitable events. The finding that depressed individuals did not demonstrate this memory advantage is consistent with previous studies reporting that depressed individuals were unable to make use of additional contextual cues in order to increase specificity of ABM retrieval (e.g. Williams & Dritschel, 1988). There was evidence from the retrieval time data that depressed individuals had impaired access to positive memories relative to the controls. This finding is consistent with a number of findings from the literature. However, there was an unusual result in that depressed individuals retrieved more specific positive than negative memories, which is in the opposite direction to predictions. This finding is inconsistent with previous findings that have usually reported lower levels retrieval of specific positive than negative ABMs (see Williams, 1996). The findings of the current study confirm the tendency of depressed individuals to retrieve overgeneral categorical memories when cued with words and furthermore demonstrate that this tendency generalises to ABM retrieval in response to important non-verbal cues. Interestingly, the findings of the current study demonstrated that this tendency in depressed individuals was particularly marked in response to faces cues, relative to the other stimuli. There is some evidence from the current study that this finding might, in part, relate to induced rumination in the depressed individuals in response to the faces. However, this explanation requires further confirmation and is unlikely to provide a complete account. Other important factors that could provide alternative/additional explanations include the possibility

that the faces required greater cognitive processing than the words or images (some evidence of this from the retrieval times of the current study) and also the fact that the faces were a generic cue might have encouraged generic retrieval style. Future research is required to differentiate between these proposals and to investigate the properties of images that act to enhance ABM retrieval.

- CHAPTER FIVE -

MEMORY BIAS FOR EMOTIONAL FACIAL EXPRESSIONS IN MAJOR DEPRESSION: DOES IT REQUIRE DIRECT PROCESSING OF VALENCE AT ENCODING?

5.1. Introduction

5.1.1. Mood-congruent memory bias in major depression

As noted in chapter one (page 22) mood-congruent memory (MCM) bias has been consistently demonstrated in patients suffering from major depression. The most robust finding (e.g. Bradley, Mogg & Williams, 1995; Watkins, Mathews, Williamson & Fuller, 1992) is that depressed individuals demonstrate superior memory for depression-relevant, self-referent words (e.g. useless) compared to positively valenced words (e.g. excited) or neutral words (e.g. moderate). This tendency has been shown to be strongest when depressed participants are asked explicitly to recall previously presented words, but has also been reported in tests of recognition memory for emotionally valenced words (Dunbar & Lishman, 1984).

A recent study (Ridout, Astell, Reid, Glen & O'Carroll, 2003) reported that a similar memory bias was observed when clinically depressed patients were given a recognition memory test for previously viewed emotional facial expressions. In their study (outlined in more detail in chapter one, page 24), clinically depressed patients and matched controls were presented with photographs of emotional faces and were asked to identify the emotion portrayed in each photograph. The participants were subsequently given a recognition memory test for these faces. The groups did not

differ on the emotion identification task, but exhibited marked differences on the recognition memory test (illustrated in figure 5.1, below), with the depressed patients exhibiting superior memory for sad faces, relative to neutral or happy expressions, and the controls demonstrating enhanced memory of happy faces, relative to the other expressions. Furthermore, depressed patients demonstrated enhanced memory of sad faces relative to controls, who in turn demonstrated superior memory of happy faces relative to the depressed patients.

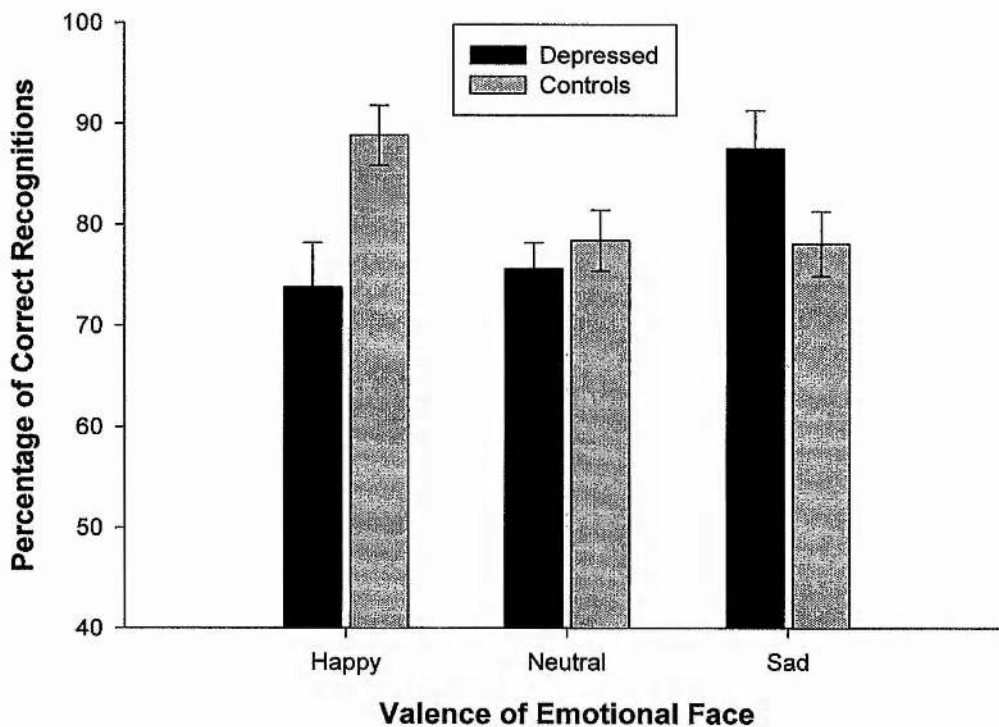


Figure 5.1. Percentage of each type of emotional faces correctly recognised by the participants during recognition memory testing (error bars show \pm one standard error of the mean) - reproduced from Ridout et al (2003).

As outlined in chapter one (page 37), the cognitive theory of depression proposed by Williams, Watts, MacLeod and Mathews (1988; cited in Williams et al, 1997)

provides a good account of these findings. According to this theory, MCM bias in depression results from strategic allocation of cognitive resources, by depressed individuals, to the elaboration of depression-relevant material during encoding. However, it should be noted that Teasdale and Barnard (1993) argued that MCM bias only occurs in circumstances that involve access to affect-related representations in the Implicational subsystem (see account of their model in section 1.5.3, page 40). According to their ICS model, MCM requires the hedonic features of a given event to be represented in the Implicational subsystem during encoding, and also for these representations to be accessed during retrieval. As the encoding task of the previous study (Ridout et al, 2003) required the participants to explicitly process the emotional content of the faces it would seem likely that the affective content of the faces will have been represented in memory, which according to the ICS model is a prerequisite of MCM bias. However, an important question that arises is *"Would the memory bias for sad faces persist if encoding conditions did not require direct processing of the emotional content of the faces?"* In order to address this question, the current study took the form of a replication of Ridout et al's study (2003) with the emotion recognition phase being replaced with a gender identification task.

It is clear that gender identification should require little or no cognitive effort on the part of the participants, thus presentation times for the faces should be very short. If the memory bias reported in Ridout et al (2003) requires explicit processing of the valence of the facial expressions, as the ICS model would suggest, then it should not be observed in the current study. However, if depressed individuals automatically process the valence of facial stimuli they encounter then it is possible that the patients will still demonstrate superior memory for the sad faces in the current study. Previous

research (e.g. Stenberg et al, 1998) has suggested that humans do process the affective valence of emotional facial expressions automatically. They also demonstrated that this automatic processing of valence exerted an influence on other ongoing cognitive activity. There is further evidence of automatic processing of emotional valence from faces in the findings reported in chapter three of this thesis (page, 77). If the MCM bias were observed in the current study it would represent an important finding as it would suggest that depressed individuals are able to demonstrate mood congruent memory for important, socially relevant, stimuli after only extremely brief presentations. Thus, if even fleeting negative expressions are present in social interactions the individual is involved in there is a chance that this interaction will be remembered as negative.

5.1.2. Overview and Predictions

Clinically depressed patients and healthy matched controls were presented with a series of photographic images of different individuals depicting one of three emotional expressions (*happiness, sadness or neutrality*). Half of the photographs featured a male, and half a female. During the encoding phase, participants were asked to identify the gender of the individuals featured in the photographs. Following a filled delay period, participants were given a recognition memory test for the faces they had viewed during the gender identification phase. The following predictions were made:

5.1.2.1. Hypothesis tested during the gender decision phase

As it was expected that gender identification would be an automatic process it was not expected that the other properties of the face (e.g. emotional valence) would influence

the participants' ability to identify the gender of the individuals featured in the photographs therefore no formal hypotheses were made for the gender identification phase of the study.

5.1.2.2. Hypothesis tested during the recognition memory phase

From Ridout et al (2003) it is expected that the depressed patients will make significantly more correct recognitions of sad faces than happy or neutral faces. Conversely it is expected that participants in the control group will make significantly more correct recognitions of happy faces than neutral or sad faces.

5.2. Method

5.2.1. Design

This study made use of a 2 (group) x 3 (valence) mixed factorial design. The between subjects factor was participant group (*depressed patients & controls*). The within subjects factor was the valence of the emotional facial expressions (*happy, sad or neutral*). The dependent variables in the decision phase were gender identification time in milliseconds and the percentage of faces assigned the correct gender. The dependent variable during the memory phase was the percentage of correct recognitions. Correct recognitions refer to recognising that a face was shown during the gender identification (encoding) phase and also recognising that a face was novel, i.e. was not presented during the gender decision phase.

5.2.2. Participants

Sixteen clinically depressed patients (5 male & 11 female) and eighteen healthy controls (4 male & 14 female) took part in the current study. According to Cohen

(1992) this sample size is suitable to detect the large effect sizes that were predicted in the current study based on previous studies (e.g. Ridout et al, 2003) addressing memory bias for emotional faces in depression (see appendix II for full details of these power analyses). The participants were recruited according to the inclusion and exclusion criteria outline in chapter two (section 2.6.3, page 55). Furthermore, upon admission they were assessed according to the standard protocol, also outlined in chapter (section 2.6.2, page 54). The two groups were matched (see table 5.1, page 154) in terms of age, sex, educational background (years of full-time education completed), and pre-morbid intellectual ability. Prior to taking part in the current study, the severity of the patients' depression was established, by one of the psychiatrists in the ADC (or in the case of five patients, by the author), using the 17-item Hamilton Rating Scale for Depression (HRSD; Hamilton, 1961). The mean HRSD score for the patients in the current study was 20 (with a range of 14 – 24).

5.2.3. Materials and Apparatus

5.2.3.1. Emotional facial expressions

The current investigation utilised the identical stimuli used in Ridout et al's study (2003). 62 grey-scale photographic images of people posed in different emotional facial expressions (20 happy, 20 sad & 22 neutral) were drawn from a set of images used in a series of studies conducted by Le Gal & Bruce (1999). Half of the photographs featured a female, whereas the remaining images featured a male. Twenty individuals (10 males, 10 females) portrayed both the happy and sad expressions, whereas the neutral expressions were portrayed by a different group of twenty-two individuals (11 males, 11 females). During one of their studies, Le Gal and Bruce (1999) presented the faces to a group of 70 undergraduate students (35

males, 35 females) and asked them to identify the emotion portrayed by each face (using a forced choice paradigm). All faces included in the current study received at least 75% subjective agreement concerning the emotion they portrayed. The stimuli presented during the gender identification task consisted of two sets (A & B) of 21 faces (5 happy, 5 sad and 11 neutral) that were compiled from the main array of 62 photographs. In Set A (see appendix XVI), eleven images (3 happy, 2 sad and 6 neutral) featured a female and ten photographs (2 happy, 3 sad and 5 neutral) were of a male. In set B (see appendix XVII) these gender ratios were reversed. The rationale for creating two sets of stimuli for the encoding phase was to control for the effect of facial distinctiveness on memory for the faces. It would be expected that highly distinctive faces would be remembered more readily than would less distinctive faces, regardless of emotional expression. Therefore, the individuals that portrayed happiness in set A were posed in a sad expression in set B and vice-versa. Furthermore, the 11 neutral expressions featured in set A were replaced in set B with an alternative set of 11 neutral images. The stimuli presented during the recognition memory phase consisted of two sets (MEM_A & MEM_B) of 42 faces. MEM_A consisted of set A from the encoding phase plus an additional 21 images (5 happy, 5 sad & 11 neutral faces; see appendix XVIII). Likewise, MEM_B consisted of set B from the encoding phase plus a novel set of 21 faces (5 happy, 5 sad & 11 neutral; see appendix XIX). Participants were presented with one set of faces (either A or B) at encoding and the corresponding larger set (MEM_A or MEM_B) during recognition memory testing.

5.2.3.2. Simple reaction time task

As previous studies (e.g. Deijen, Orlebeke & Rijdsdijk, 1993; Ilsley et al., 1995) have reported that major depression is associated with psychomotor retardation it would be expected that the patients would be slower than the controls to respond to the face stimuli presented in the current study, which could distort interpretations of the patients' gender identification times. Therefore, a measure of simple reaction time was included in the current study in order to allow differences between the groups in terms of detecting and responding to stimuli to be controlled for when analysing the participants' response times to the faces. The simple reaction time task included in the present study required the participants to maintain their attention on a focus point (cross) in the centre of the screen for the duration of the task (approx 3 minutes). At various points during the task a stimulus (a solid red circle) appeared in place of the cross and the participants were required to press a key (marked "off") in order to make the circle disappear. They were asked to press the key as quickly as they could once the circle had appeared. However, it was stressed that they should wait until the circle appeared before pressing the "off" key. Overall, the task consisted of 60 stimuli (plus 10 practice trials, which were completed prior to the main set of trials). The stimuli did not appear at regular intervals but rather appeared after one of five inter-stimulus intervals (500, 750, 1000, 1250 & 1500 milliseconds). Although equal numbers of stimuli (12) followed each ISI, the order in which each interval appeared was randomised for each participant, in order to prevent the participants anticipating the appearance of the stimuli.

5.2.3.3. Stimulus presentation

During the gender decision, recognition memory and simple reaction time tasks a Macintosh PowerBook 3400c loaded with the Superlab program (version 1.74, Cedrus Corporation, 1992; Phoenix Arizona) was used to present the stimuli (in a random order) and to measure and record the participants' responses. The size of the computer screen was 250 mm by 175 mm and the dimensions of each face stimuli on the screen was 70 mm (height) by 50 mm (width). The diameter of the circle stimuli presented during the simple reaction time task was approximately 20 mm.

5.2.3.4. Measurement of self-rated mood

The 21-item Beck Depression Inventory (BDI - Beck *et al.*, 1961) and the 14-item Hospital Anxiety and Depression Scale (HADS - Zigmond & Snaith, 1983) were used to establish the participants' mood during the week prior to the test session (including the day of testing). The rationale for using these measures is outlined in full in chapter two.

5.2.3.5. Assessment of pre-morbid intellectual ability

The National Adult Reading Test (NART; Nelson & Williamson, 1991) was included in the current study in order to provide an estimate of the participants' intellectual ability. The rationale for the inclusion of this task is also outlined in full in chapter two.

5.2.3.6. Other tasks (distracter tasks)

The Digit Symbol Substitution Task (DSST) and Digit Span Task both drawn from the WAIS-R IQ test (Wechsler, 1981) were included as distracter tasks during the five-minute delay period between the encoding and recognition memory testing.

5.2.4. Procedure

5.2.4.1. Gender identification Task

The participants were presented with one of the sets (A or B) of 21 faces and were asked to indicate, via a key press, whether the person featured in each photograph was a male or female. They were urged to respond as quickly and accurately as they could. Following completion of the gender identification task there was a five-minute filled delay, during which time the participants were asked to complete the digit symbol and digit span tasks (Wechsler, 1981). Participants were subsequently given a recognition memory test for the faces they had viewed during the gender decision phase.

5.2.4.2. Recognition Memory Test for Emotional Faces

During memory testing participants were presented with one of the two sets (MEM_A or MEM_B) of 42 faces. The participants were required to indicate, via a key press, whether they recognised the face as being from the set they had viewed during the first part of the study. They were asked to make their decisions as quickly and accurately as possible. Once all of the faces had been viewed and judged, the participants were asked to complete the simple reaction time task. Finally, they were assessed on the NART and asked to complete the self-report measures of mood (BDI and HADS).

5.2.5. Data Analysis

A MANOVA was conducted in order to establish if there were any significant differences between the two groups in terms of age, educational background (years of full-time education completed), intellectual ability (full-scale IQ score, estimated from the number of reading errors on the NART) or self-rated mood (indexed by the BDI & HADS). A chi-squared test was utilised to establish if the two groups differed in terms of the number of males and females making up each group. A further MANOVA was conducted to establish if the two groups differed in their performance on the digit symbol, digit span and simple reaction time tasks. Participants' mean simple reaction time was subtracted from their gender identification time in order to control for any group differences in detecting, and responding to, the face stimuli. The adjusted gender identification times and the percentage of correct recognitions made by the participants during the recognition memory phase were all analysed using 2 (group) x 3 (valence) repeated measures ANOVA, with face valence as the within subjects factor and participant group as the between subjects factor. Subsequent pair-wise comparisons were conducted using LSD tests (where a-priori predictions were made) and Bonferroni corrected t-tests (where no prior predictions were made). Significant interactions were investigated using one-way and two-way factorial ANOVA, paired and independent t-tests.

5.3. Results

5.3.1. Participant Characteristics

Analysis of the participant characteristics presented in table 5.1 revealed that the two groups were well matched in terms of age; $F(1, 32)=1.6$, $p>0.05$, sex; $\chi^2(1)=0.7$, $p>0.05$, educational background; $F<1$, and pre-morbid IQ; $F<1$. Although the

participants did not differ significantly in terms of their general intellectual ability (estimated from the NART), the estimated IQ scores for both groups are relatively high, which could reflect a sampling bias. It is possible that patients with higher IQ would have been more willing to participate or perhaps the clinicians were more likely to consider patients with higher IQ as suitable participants for the current study.

Table 5.1. Characteristics of the individuals in each participant group

	Depressed	Controls
	(N=16)	(N=18)
Age	43.7 (2.8)	39.3 (8.8)
Sex	11 females, 5 males	14 females, 4 males
Y of FTE	12.6 (0.9)	13.4 (0.5)
Full-scale IQ⁺	113.6 (1.1)	114.1 (0.8)
BDI (21-item)*	31.8 (1.8)	2.6 (0.4)
HADS (Anxiety)*	14.1 (0.5)	3.4 (0.7)
HADS (Depression)*	14.6 (0.7)	0.8 (0.2)

Y of FTE= Years of Full-time Education, BDI=Beck Depression Inventory, HADS=Hospital Anxiety & Depression Scale. ⁺Estimated from participants' error score on the National Adult Reading Test. * Significantly different at 0.001 level

As expected, analysis of the participants' self-rated mood revealed that the patients produced significantly higher ratings of depression than did the controls; on both the BDI; $F(1, 32)=277.5$, $p<0.001$ and the HADS depression sub-scale; $F(1, 32)=418.6$, $p<0.001$. Also as expected, the patients produced significantly higher ratings of anxiety on the HADS anxiety sub-scale than did the controls, $F(1, 26)=147.4$, $p<0.001$. Analysis of the relative contribution of depression and anxiety in explaining

the observed memory results of the current study revealed that it was consistently depression and not anxiety that accounted for these effects (see appendix XX for full details of these analyses).

5.3.2. Digit Symbol and Digit Span Tasks

Analysis of the participants' performance on the digit symbol task revealed that depressed patients made significantly fewer symbol substitutions ($\mu=42.3$, $SE=2.3$) than did the controls ($\mu=58.0$, $SE=2.1$); $F(1, 32)=25.5$, $p<0.001$. However, although the depressed individuals remembered fewer digit spans ($\mu=15$, $SE=0.6$) than did the controls ($\mu=16.9$, $SE=0.7$), this difference only approached conventional significance, $F(1, 32)=3.9$, $p=0.056$.

5.3.3. Simple Reaction Time

Analysis of the participants' simple reaction time revealed that the patients were significantly slower to respond to the stimuli ($\mu=355.4\text{ms}$, $SE=23.7$) than were the controls ($\mu=324\text{ms}$, $SE=13.6$); $F(1, 32)=5.5$, $p<0.05$. Therefore, the participants' simple reaction times were subtracted from their gender identification times in order to control for this difference in general psychomotor speed.

5.3.4. Gender Identification Time

Inspection of the gender identification times (illustrated in figure 5.2) revealed that there was no significant group x valence interaction, $p>0.05$. Likewise, there was no significant effect of face valence on the gender identification times of the participants and no significant difference between the two groups in terms of the speed of gender identification, both tests $p>0.05$.

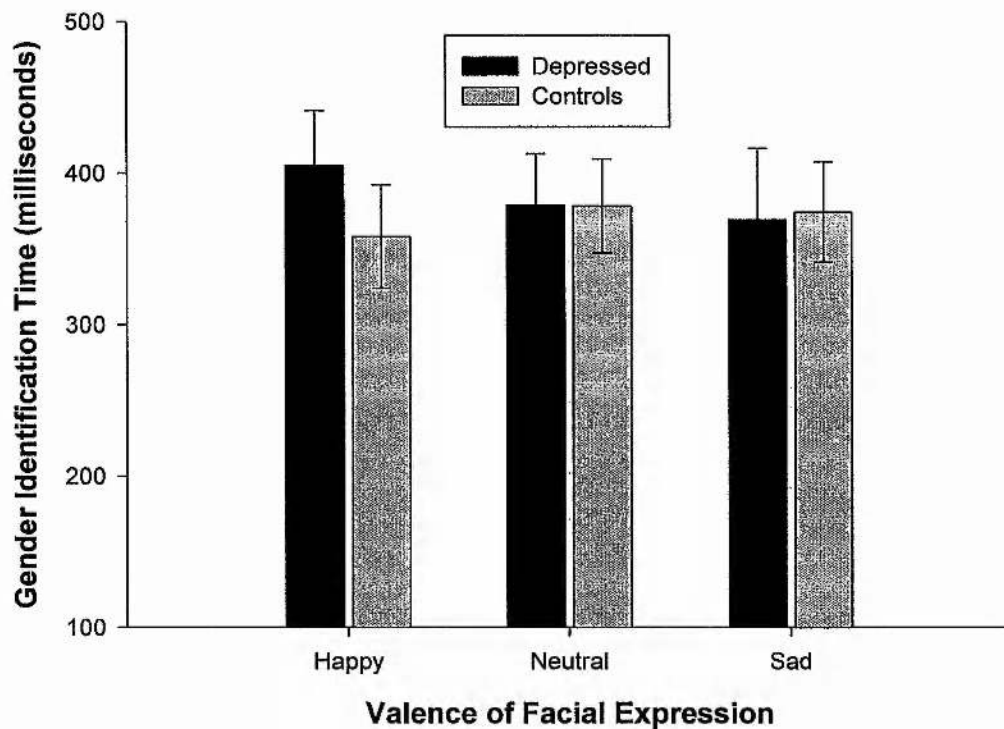


Figure 5.2. Mean gender identification times of the participants, as a function of the valence of emotional expression portrayed in the photographs (error bars show \pm one standard error of the mean)

5.3.5. Percentage of Correct Recognitions

From Ridout et al (2003) it was predicted that the depressed patients would make significantly more correct recognitions of sad faces than happy or neutral expressions. Conversely it was expected that the participants in the control group would make significantly more correct recognitions of happy faces than neutral or sad expressions. In line with these predictions, analysis of the percentage of correct recognitions revealed a group \times valence interaction (illustrated in figure 5.3) that approached conventional significance; $F(2, 64)=3.1, p=0.053$.

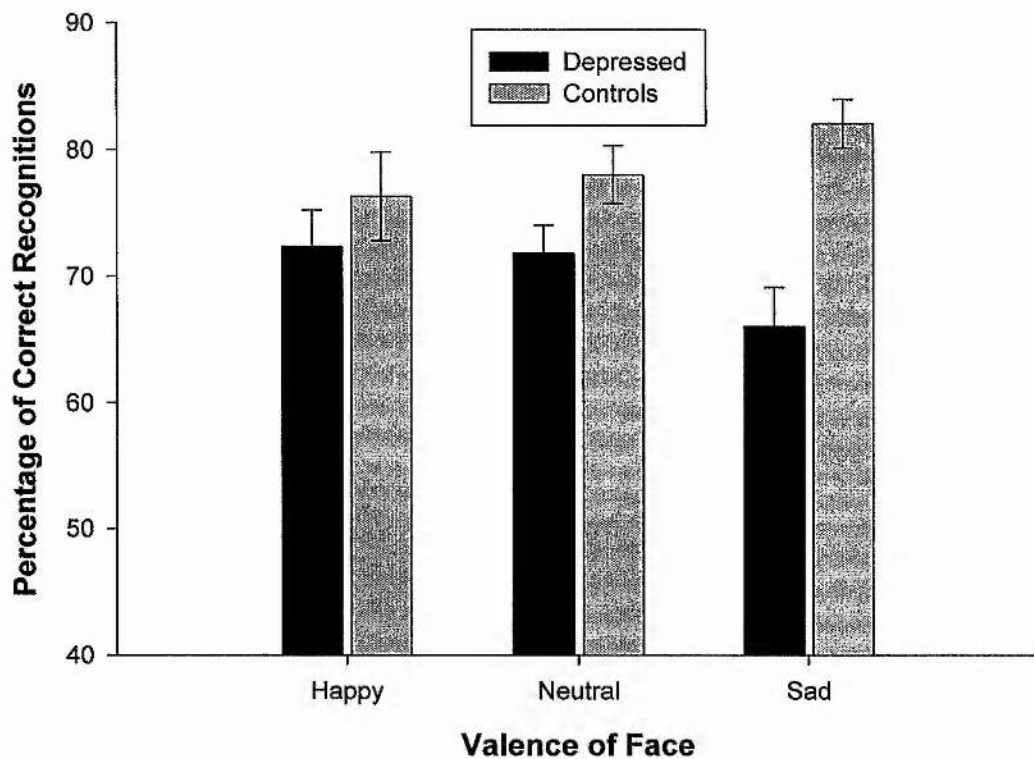


Figure 5.3. Percentage of faces correctly recognised by the participants, as a function of the valence of the faces (error bars show \pm one standard error of the mean)

However, further analysis revealed that, contrary to predictions, the percentage of sad faces correctly recognised by the depressed individuals did not differ significantly from the percentage of happy or neutral expression they correctly recognised. Furthermore, the percentage of happy faces that were correctly recognised by the healthy participants did not differ significantly from the percentage of sad or neutral expressions they correctly recognised, which is also in contrast to the predictions. Overall, the two groups did not differ significantly in terms of the percentage of happy and neutral faces they correctly recognised, $p > 0.05$. Interestingly, controls

made significantly more correct recognitions of sad faces ($\mu=82\%$, $SE=1.9$) than did the depressed patients ($\mu=66\%$, $SE=3.1$); $t(32)=4.5$, $p<0.001$.

5.4. Discussion

The aim of the current study was to establish if the MCM bias for sad faces, demonstrated by a group of depressed patients in a previous study (Ridout et al, 2003), would still be observed in circumstances that did not require direct processing of the emotional expression of the faces during encoding.

5.4.1. Gender Identification Times

No formal hypotheses were made for this phase of the study as it was expected that gender identification would be an automatic process requiring little or no cognitive effort. The focus of this study is whether these brief presentations of faces with no explicit reference to the valence of the expressions portrayed would still result in a mood-congruent memory bias. If it did that would suggest that automatic, unconscious processing of the emotion portrayed in a face is enough to lead to the bias in memory function.

5.4.2. Percentage of Correct Recognitions

During the recognition memory phase it was expected that the depressed patients would make significantly more correct recognitions of sad faces than happy or neutral faces. Conversely it was expected that participants in the control group would make significantly more correct recognitions of happy faces than neutral or sad faces. Contrary to these predictions, the depressed individuals did not exhibit MCM for the sad faces they viewed during the gender identification phase. Also contrary to the

predictions, the healthy controls failed to demonstrate a MCM bias for previously viewed happy expressions. Interestingly, they appeared to demonstrate a memory bias in the opposite direction to that predicted, i.e. they exhibited superior memory for the sad faces relative to the patients.

These findings suggest that, in line with the previous literature (e.g. Williams et al, 1997), MCM bias in depression is not related to automatic unconscious processing of the emotional content of the stimuli, but rather requires explicit processing of the stimuli to-be-remembered in order to elaborate them in memory. Furthermore, as automatic processing of the faces for gender clues was all that would have been required to identify the gender of the individuals featured in the photographs, it would also seem unlikely that the affective features of the photographs would have been registered in the Implicational subsystem, which according to Teasdale and Barnard (1993) is a pre-requisite of MCM bias.

The finding that healthy participants did not demonstrate a MCM bias for happy expressions can also be explained in terms of the notion that the processing required to identify the gender did not lead to elaborative encoding of the faces. However, the evidence that they demonstrated superior memory for the sad faces, relative to the patients is anomalous, and would not fit with this notion. As noted above, an explanation in terms of elaboration is unlikely, as the depth of processing required to identify the gender would not have encouraged elaboration of the faces. It is plausible that this finding represents a difference between the groups in implicit memory for the faces. However, this finding would require replication and further investigation before any strong conclusions could be drawn.

5.4.3. Comparison of the current study and Ridout et al (2003)

The previous study conducted by Ridout et al (2003) reported that a significant MCM bias for sad faces in depressed patients (see figure 5.4-A, below). During the encoding phase of the original study, participants were required to identify the emotion portrayed by the faces, which it can be argued would have encouraged elaboration of the faces. Furthermore, as the emotion of the faces was salient, this task would plausibly have led to these affective elements of the faces being encoded. Both of these findings would account for the observed MCM biases. In the current study, the emotion recognition phase was replaced with a gender identification task and there was no longer evidence of an MCM bias in the depressed patients (see figure 5.4-B).

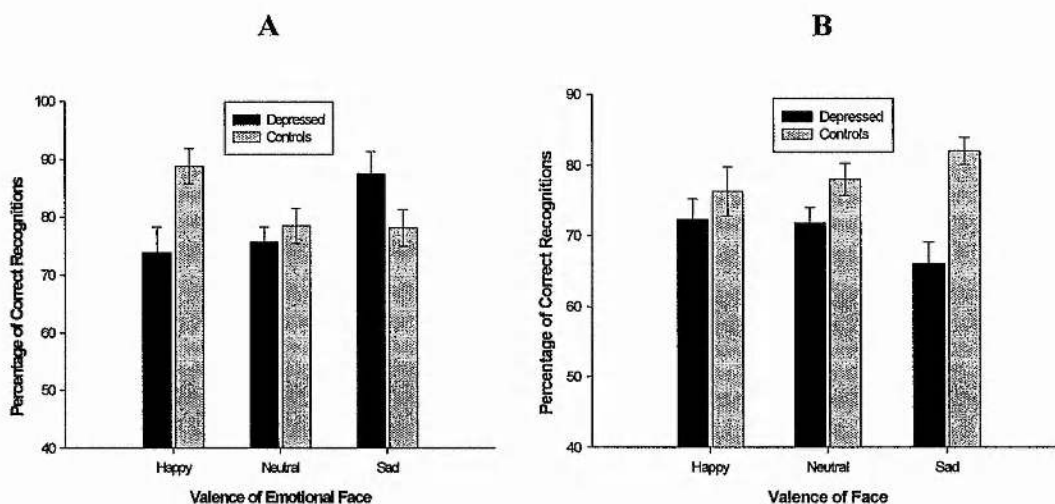


Figure 5.4. Comparison of the pattern of recognition memory exhibited by the participants (depressed & controls) in (A) Ridout et al (2003) and (B) the current study

The failure, in the current study, to replicate the MCM bias for sad faces in the depressed patients suggests that this bias is dependent upon direct processing of the valence of the faces at encoding. This notion corresponds with the ICS model

proposed by Teasdale and Barnard (1993), who proposed that a prerequisite of MCM bias is the representation of the affective features of stimuli in the Implicational subsystem and the subsequent access to these representations at retrieval.

However, another point that requires consideration is the depth of processing that would have been required by the different encoding tasks. From Ridout et al (2003) it can be seen that on average it took the patients around two and a half seconds and the controls around one and a half seconds to identify the emotion portrayed by the faces. In the current study, it took the patients less than a second and the controls just over half a second to identify the gender of the faces. From these findings it is clear that the gender identification task will have required shallower processing than would the emotion identification phase. A potential future study could involve a task that would require deeper processing of the faces whilst still avoiding explicit processing of the emotion. For example, participants could be asked to estimate the age of the individuals in the photographs.

5.4.4. Summary and Conclusions

At encoding, the two groups did not differ significantly in terms of the time taken to identify the gender of the individuals featured in the photographs. Importantly, the valence of the faces did not exert any influence on the participants' gender identification times. At recognition memory testing the depressed patients did not exhibit the predicted MCM bias for sad faces. Likewise, the controls did not exhibit the expected positive bias for happy faces. There was some evidence of an anomalous mood incongruent bias in the controls, which plausibly relates to differences in priming or implicit memory function. However, there is a need to replicate this

finding and to investigate this phenomenon further before any conclusions can be drawn. Taken as a whole, the current results suggest that the MCM bias for faces reported in Ridout et al (2003) is not a consequence of automatic processing of face valence but rather requires direct processing of the emotion content of the faces. This notion corresponds with Teasdale and Barnard (1993) who proposed that a prerequisite of MCM bias is encoding of the affective features of the stimuli, which can subsequently be accessed during retrieval. Ridout et al (2003) proposed that biased memory for the sad faces of significant others could act to colour the patients' interpretation of social interactions in which they were involved. The current finding suggests that this bias would only occur if the patients became aware of the emotion being portrayed by the person with whom they were interacting. In line with this notion, previous work on selective attention has reported that depressed individuals are not more sensitive to detecting negative material in their environment, but rather exhibit a deficit in disengaging from negative material that has become the focus of attention. It is likely that this 'locking on' of attention to depression-relevant material would subsequently lead to enhanced memory for these stimuli.

-CHAPTER SIX-

EMOTION RECOGNITION AND SOCIAL PERCEPTION IN MAJOR DEPRESSION: IMPAIRED INTERPRETATION OF VIDEOTAPED SOCIAL INTERACTIONS?

6.1. Introduction

6.1.1. Background

As noted in chapter one (section 1.4.3, page 30) there is evidence that clinical depression is associated with impaired social functioning (e.g. Cooley & Nowicki, 1989). Furthermore, other studies have demonstrated that depressed individuals exhibit deficits in social perception. Social perception has been defined as the ability to read social cues and use them to make judgements about the behaviour, attitudes and emotions of others (McFall, 1982). For example, depressed individuals tend to provide negative interpretations when asked to judge stories concerning social situations that have an ambiguous meaning (e.g. Krantz & Hammen, 1979; Butler & Mathews, 1983). Furthermore, in a recent study, Ambady and Gray (2002) reported that depressed mood (indexed by elevated BDI score) impaired the accuracy of participants' social judgements. It would seem likely that these deficits in social perception contribute to the problems that depressed individuals experience in social interactions. In line with this notion, Persad & Polivy (1993) proposed that deficits in recognising emotional facial expressions might contribute to the difficulties in social functioning that are associated with clinical depression. Facial expressions are extremely powerful social stimuli that are highly salient features of most human interpersonal interactions. Thus, it is clear that deficits in processing the message

being transmitted by these stimuli could have serious consequences for depressed individuals, such as creating misunderstandings between them and their significant others (e.g. spouse), which in turn could lead to interpersonal tension and possibly social isolation. The next section of this study will consider the evidence that clinical depression is associated with changes in the processing of emotion from faces, relative to healthy individuals. Furthermore, the limitations with previous studies addressing emotional processing and social perception in clinical depression will also be considered.

6.1.2. Processing of emotional faces in major depression

The evidence that major depression is associated with changes in the accuracy of processing emotion portrayed by facial expressions has been equivocal. Some studies (e.g. Feinberg, Rifkin, Schaffer & Walker, 1986; Persad & Polivy, 1993) have reported that depressed patients exhibit a general deficit in detecting emotion from faces. However, other studies (e.g. Mandal & Bhattacharya, 1985; Murray & Perret, 2000) have reported that depression is associated with superior recognition of sadness relative to the other emotions. Conversely, there have been other studies (e.g. Loeb et al, 1964; Ridout et al, 2003) that have reported no differences between depressed participants and healthy controls on emotion recognition from facial cues. The variability of these findings could relate to a number of factors, including the type of emotional stimuli used (e.g. schematic drawings, photographs etc), the make up of the depressed sample (e.g. clinical, analogue etc) and the type of task used to investigate the accuracy of emotion recognition in the participants (e.g. forced choice labelling, stimulus description etc). Thus, it is clear that there is a need for further investigation of emotional processing from faces in major depression.

One criticism that could be levelled at many of these previous studies is that the stimuli utilised have been static photographs of posed expressions. In everyday social interactions faces are not static but rather are dynamic and rapidly changing. Furthermore, in normal social exchanges other “channels” of information (e.g. body posture, tone of voice, gestures) combine with the facial expressions in order to transmit the desired message. Therefore, correct understanding of social interactions requires accurate processing and integration of these various sources of information. As mentioned above, depressed individuals appear to exhibit impaired understanding/interpretation of verbal descriptions of social interactions. However, it can be argued that these studies lack ecological validity, as under normal circumstances interpretation of social exchanges requires spontaneous judgements “on-line” rather than a considered reflection. Therefore, what is required is a test of emotion recognition and social perception that includes stimuli that resemble “real world” social exchanges. A study addressing depressed individuals’ processing of naturalistic social interactions would represent a significant advance in the understanding of how depression affects social perception. Therefore, the aim of the current study is to conduct such an investigation.

6.1.3. The Awareness of Social Inference Test (TASIT)

The Awareness of Social Inference Test is a recently developed neuropsychological tool for assessing social perception in patients that have suffered traumatic brain damage (McDonald, Flanagan & Rollins, 2002). TASIT consists of three related sections, all of which involve the presentation of brief videotaped social interactions to the participants and asking them to make judgments concerning the behaviour of the featured protagonists. The first section of TASIT provides an ecologically valid

test of the participants' ability to recognise spontaneous displays of the primary emotions, whereas the second and third phases assess the participants' ability to make inferences about the thoughts, feelings and intentions of the characters featured in the vignettes.

McDonald, Flanagan, Rollins & Kinch (2003) reported that patients with traumatic brain injury (TBI) exhibited a general deficit in recognising the primary emotions, with particular impairment of fear, disgust, and neutral displays. Patients with TBI were indistinguishable from healthy individuals in terms of their understanding of sincere exchanges and interactions involving 'white lies'. However, they demonstrated significantly impaired understanding of sarcasm. These findings suggest that, whilst patients with TBI have little problem understanding literal meanings, they are impaired in detecting (or understanding) the implied meaning of social interactions. As TASIT has been shown to be a reliable measure, with good ecological validity, that is able to detect subtle changes in social perception associated with certain clinical groups, it would appear to be the ideal tool with which to conduct the proposed study.

6.1.4. TASIT and Major Depression

TASIT has not previously been used to assess emotional processing in clinically depressed patients. However, it could be argued that such a study will represent an important extension to previous work on emotion recognition and social perception in this patient group. Based on the findings of previous studies (reported above), it might be expected that, relative to healthy participants, the depressed patients would be impaired on the emotion evaluation phase of TASIT. Furthermore, as a number of

studies have reported that depressed patients are more sensitive to detecting negative than positive emotions, it might be expected that the depressed patients would exhibit a negative bias in their emotion recognition.

As noted above, McDonald et al. (2003) reported that patients with TBI exhibited impaired comprehension of sarcastic interactions. It is possible that this impairment was a consequence of a deficit in executive processing in these patients. In line with this notion, it would seem likely that the patients reported in McDonald et al (2003) would have experienced injury to the frontal lobes, as this portion of the brain is particularly susceptible to damage in cases of traumatic closed head injury. Furthermore, there is considerable evidence that frontal lobe damage is associated with marked impairment of executive processing, which also provides support for this proposal.

If impaired comprehension of sarcasm is related to deficits in executive function then it might be expected that depressed individuals would also demonstrate similar impairments in understanding these exchanges, as there is considerable evidence that major depression is associated with marked deficits in executive processing (see section 1.2.4, page 9). Furthermore, if executive processes are involved in the comprehension of sarcasm then it would be expected that individuals who demonstrate impaired interpretation of sarcasm would also exhibit deficits on other cognitive tasks that tap executive processing. In order to address this proposal, the participants were also assessed on a number of neuropsychological tests that are thought to tap executive processing.

Impaired comprehension of sarcasm in depressed patients could have negative consequences in terms of their social relationships. For instance, many people use sarcasm in their everyday conversations in an affectionate manner in order to 'send up' their conversational partner. This is particularly common amongst friends and more intimate relationships. With this in mind, insensitivity to sarcasm could lead to misunderstandings between depressed patients and their significant others. For example, if a patient failed to register the sarcasm expressed by her husband's voice and facial expression when he says, "*Yeah, I think you're so fat*" then she could interpret this as an insult about her weight, which in turn could contribute to interpersonal tension and ultimately lead to social isolation.

6.1.5. Overview and Predictions

Clinically depressed patients and healthy matched controls will be presented with all three sections (Emotion recognition, Social Inference-minimal & Social Inference-enriched) of the Awareness of Social Inference Test (TASIT). In addition to TASIT the participants will be asked to complete a number of tasks that assess participants' executive function (the traditional Stroop colour-naming task, FAS verbal fluency, & the Hayling's sentence completion task). The following predictions were made:

1. During the Emotion Recognition phase it was expected that the depressed patients would correctly recognise significantly fewer of the emotional displays than would the controls. However, it was expected that the depressed patients would demonstrate superior recognition of the negative emotional expressions relative to positive.

2. During the Social Inference (minimal) phase of the current study it was expected that the depressed patients would make significantly fewer correct interpretations of the sarcastic interactions than would the controls. However, it was not expected that the two groups would differ on the sincere interactions.
3. Likewise, during the Social Inference (enriched) phase it was expected that the depressed patients would make significantly fewer correct interpretations of the sarcastic interactions than would the controls. However, it was not expected that the two groups would differ on the interactions involving 'white lies'.

6.2. Method

6.2.1. Design

All three phases of the current study that involved TASIT utilised a 2 x 2 mixed design. For all three elements the between subjects factor was group (depressed & controls). During the Emotion Recognition phase the within subjects factor was the valence of the emotion expressed in the video clips (positive or negative). The dependent variable was the percentage of emotional displays correctly recognised. During the Social Inference phases (SIM & SIE) the within subjects factor was the type of social interaction. The social interactions presented during the SIM phase featured protagonists that were either being sincere or sarcastic. The social interactions presented during the SIE phase featured protagonists that were either telling 'white lies' or being sarcastic. The dependent variable for both Social Inference phases was the percentage of correct interpretations of the different social interactions.

6.2.2. Participants

Fourteen clinically depressed outpatients (3 males & 11 females) and fourteen healthy individuals (2 males & 12 females) took part in the current study. This sample size was considered reasonable, as it was comparable to previous studies addressing emotion recognition in major depression (e.g. Persad & Polivy, 1993; who tested 16 depressed patients and 16 controls). The participants (*depressed & controls*) were recruited according to the inclusion and exclusion criteria cited in chapter two (section 2.6.3, page 50). Furthermore, upon admission to the study they were assessed according to the standard protocol outlined in chapter two (section 2.6.2, page 49). The characteristics of the individuals making up the two participant groups are reported in table 6.1 (page 162). The two participant groups were matched in terms of age, sex, educational background, and pre-morbid intellectual ability. Prior to their participation in the study, the severity of the patients' depression was quantified by one of the psychiatrists at the ADC (or for six of the patients by the author) using the 17-item Hamilton Rating Scale for Depression (HRSD; Hamilton, 1961). The mean HRSD score for the patients in the current study was 21.9 (with a range of 16 – 25.5). It should be noted that, in addition to this study, the participants (*depressed & controls*) were included in the experiment reported in chapter seven (page 177), acting as clinical and healthy controls for a group of patients that had undergone neurosurgical intervention for chronic, treatment-refractory depression.

6.2.3. Materials and Apparatus

6.2.3.1. The Awareness of Social Inference Test (TASIT)

The stimuli used during the *Emotion Recognition* phase of TASIT consisted of two sets (A & B) of 28 short video clips (each lasting 15 – 60 seconds) of simple social

interactions (a further video clip was provided in order to allow the participants to practice the task). The video clips featured either a single individual (speaking on the telephone or directly addressing the viewer) or two different individuals engaged in conversation. In each scene the central protagonist portrayed (via their facial expression, body posture & tone of voice) one of seven emotions (*happiness, sadness, surprise, anger, anxiety, disgust & neutral affect*). Each emotion was displayed in four separate video clips (presented in a pseudo-random order). Four printed response cards were provided to illustrate the possible responses for the participants. Each response card featured seven emotional descriptors (*happy, sad, neutral, angry, surprised, revolted & anxious*) printed in a different order (a fifth response card was also provided for use with the practice clip).

The stimuli used during the second phase of TASIT (*Social Inference – Minimal*) consisted of two sets (A & B) of 15 video clips of simple social interactions between pairs of individuals (each lasting 15 to 60 seconds). In a third of these interactions the protagonists are being sincere (their facial expression, tone of voice are congruent). Conversely, a third of the exchanges involve one of the protagonists being sarcastic. The final third of the interactions involved paradoxical sarcasm, i.e. the viewer can only make sense of the text if they realize that one of the individuals is being sarcastic. For example, Martin: "Do you have the tickets?" Helen: "No I burnt them" Martin: "Good, can I have them then please". Following each scene the participants were asked four questions concerning the actions, thoughts and feelings of the protagonists and also about the meaning of the text (e.g. Do you think Martin was annoyed with Helen?).

The stimuli used during the final phase of TASIT (*Social Inference – Enriched*) consisted of two sets (A & B) of 16 video clips of simple social interactions between two individuals. In all of these interactions the speaker is saying something that is contrary to what they actually think. In half of the interactions they are trying to conceal their true thoughts from the other individual by telling a ‘white lie’. However, in the other half of the exchanges the speaker uses sarcasm to deliberately make clear to the other individual that their true feelings are contrary to the words that they are actually saying. In this section of the task the participants are provided with additional information concerning the true state of affairs and the speaker’s true thoughts and feelings. These cues take the form of either a visual cue (e.g. an empty CD box visible to the viewer when the speaker says “Yes, Simon has returned my CD”) or a verbal cue in the form of an epilogue or prologue in which one of the protagonists is seen by the viewer to express their true feelings to a third party. There are eight visual cues and eight verbal cues (four of each during “lie” scripts and four of each during “sarcasm” scripts). Following the presentation of each interaction (including the verbal or visual cue) the participants were asked questions in the same format as those asked in the *Social Inference (minimal)* section of the task (see above). All of the video clips making up TASIT were digitised and presented to the participants, via a PC laptop, in a Microsoft PowerPoint presentation. Printed score sheets containing instructions and the questions for sections two and three of TASIT were also provided with the task.

6.2.3.2. Tasks Assessing Executive Processing

Three neuropsychological tasks (the traditional Stroop colour-naming task, FAS verbal fluency, & the Hayling’s sentence completion task) were included in the

current study in order to assess the participants' executive functioning. The Stroop task included in the current study consisted of two printed sheets of A4 each containing 120 stimuli. The experimental sheet consisted of the words 'blue', 'green', 'red' and 'brown' printed in incongruent colours (e.g. the word 'blue' printed in red ink). The order of words and colours was pseudo-randomised (i.e. it was ensured that no coloured ink or word appeared consecutively). On the control sheet the colour words are replaced with arrays of capital X's printed in the same colours.

During the FAS verbal fluency task the participants were asked to provide as many words as they could that began with the letters 'F', 'A' and 'S'. Participants were instructed to avoid proper nouns (e.g. Bristol), repeating words with alternative endings (e.g. eat, eating, eaten) and swear words. Participants were given 60 seconds for each letter to produce as many words as they could (according to the rules).

The Hayling's sentence completion task is made up of two related sections. The first section consists of 15 printed sentences (plus two practice stimuli) that have the final word missing (e.g. "The old house will be torn..."). The sentences are read out to the participants, whose task is to complete the sentence with a word that will make sense (e.g. for the above example the word "down" would be acceptable). The second section also consists of 15 sentences (plus two practice stimuli) with the final word omitted. However, the participants' task is to complete the sentence with a word that does not make sense and that is not related to the meaning of the sentence (e.g. in response to the sentence "London is a very busy..." a suitable response would be "doormat").

6.2.3.3. Assessment of Self-rated mood

As in all previous studies making up this thesis the participants' recent mood was assessed using the 21-item Beck Depression Inventory and the 14-item Hospital Anxiety and Depression Scale (see chapter 2 for rationale for using these measures).

6.2.3.4. Assessment of Pre-morbid Intellectual Ability

Participants completed the National Adult Reading Task in order to provide an estimate of their general intellectual ability (the rationale for using this test is outlined in chapter 2).

6.2.4. Procedure

6.2.4.1. General Assessment

At the outset of the session, once general demographic information had been collected, the participants were asked to complete the BDI and HADS mood questionnaires. Upon completion of these the participants were assessed on the NART (according to the standard procedure) and were then presented with the Stroop task. The order that they completed each sheet of the Stroop (experimental/control) was counterbalanced across all participants. Upon completion of the Stroop task they were assessed on the FAS Verbal Fluency and Hayling's sentence completion tasks. Participants were subsequently assessed on all sections of TASIT.

6.2.4.2. The Awareness of Social Inference Test (TASIT)

The participants were presented with all three sections of one of the versions of TASIT (either A or B). During the *Emotion Recognition* phase the participants were presented the video clips one at a time and were asked to watch the clips to the end.

Following each stimulus the participants were asked to identify (from the response cards) the emotion they considered was being displayed by the central character in the video clip. The participants were informed that if they considered that more than one emotion was present that they should report which was the strongest emotion present. The experimenter marked down the participant's response on the scoring sheet provided with the test (see appendix XX). Following each response, the participants were asked to place the response card they had just used to the back of the pack of four (in order to change the order that the seven emotion descriptors appeared to the participants). Once the participants had viewed and responded to all 28 video clips from section one they went straight on to complete section two of TASIT.

During the *Social Inference (Minimal)* phase the participants were presented with the 15 video taped social interactions and were instructed to watch the clips carefully right to the end. Following each clip the participants were asked the four questions that were assigned for each clip. The possible responses for the participants to the questions were 'yes', 'no' and 'don't know', although it was stressed that participants should try wherever possible to respond with either 'yes' or 'no'. The experimenter read out each question in turn and marked down the participants response in the space provided on the record sheet (see appendix XX). Once all clips making up section two of TASIT had been viewed and responded to by the participants they went straight on to complete the final section.

During the *Social Inference (Enriched)* phase the participants were presented with the 16 video taped social exchanges (including the visual/verbal cues) and were asked to watch each clip carefully right to the end. In line with section two, following each clip the participants were read the relevant questions and, as before, were asked to give a

'yes', 'no' or 'don't know' response (see appendix XX). Once the participants had viewed and responded to all of the clips in this section they were informed about the aims of the study, given a further opportunity to ask questions pertaining to the study, and then thanked for their participation in the study.

6.2.5. Data Analysis

A MANOVA was conducted to establish if the two groups differed significantly in terms of age, educational background (years of full-time education), general intellectual ability (estimated from the NART error score), verbal fluency, scaled error score on section two of the Hayling's sentence completion task, Stroop interference index (% increase in colour-naming time from control to experimental condition), number of Stroop errors, and self-rated mood (indexed by their scores on the BDI and HADS). Details concerning the scoring procedure for TASIT are given in appendix XX. The percentage of emotional displays correctly recognised during the Emotion Recognition phase of TASIT was analysed using a 2 (group) x 2 (valence) repeated measures ANOVA. The percentage of correct interpretations of the social interactions made by the participants during section two of TASIT (Social Inference Minimal) was analysed using 2 (group) x 2 (type of social interaction) repeated measures ANOVA. A further 2 x 2 repeated measures ANOVA was used to analyse the percentage of correct interpretations made by the participants during the third section of TASIT (Social Inference – Enriched). Subsequent pair-wise comparisons were made using Least Significant Difference tests where a-priori predictions were made and Bonferroni tests where no such predictions had been made. Significant interactions were investigated using paired and independent t-tests, with alpha adjusted where appropriate.

6.3. Results

6.3.1. Participant Characteristics

Analysis of the participant characteristics (presented in table 6.1, below) revealed that the ages of the participants making up the two groups differed significantly, $F(1, 26)=4.3$, $p<0.05$. Furthermore, the groups also differed in terms of the years of full-time education they had completed, $F(1, 26)=5.0$, $p<0.05$. Therefore, these differences were controlled for in all subsequent analyses, using ANCOVA with age and education as covariates. Importantly, the two groups did not differ in terms of their overall intellectual ability (estimated from the participants' NART error scores), $F<1$. However, it should be noted that the estimated IQ scores appear to be relatively high, which might represent a response bias in terms of the individuals who are likely to agree to participate or on the part of the clinicians in terms of who they would approach to take part in the study.

As expected, the depressed patients produced significantly higher ratings of depression than did the controls; on both the BDI; $F(1, 26)=263.9$, $p<0.001$ and the HADS depression subscale; $F(1, 32)=191.8$, $p<0.001$. Also as expected, the patients produced significantly higher ratings of anxiety on the HADS anxiety subscale than did the controls; $F(1, 26)=104.7$, $p<0.001$. Analysis of the relative contribution of depression and anxiety to the observed deficits in emotion recognition and social perception revealed that it was depression and not anxiety that was the most significant factor in explaining these deficits (see appendices XXI & XXII for full details of these analyses)

Table 6.1. Characteristics of the individuals making up the two participant groups

Characteristic	Depressed (N=14)		Controls (N=14)		Significance
	<u>Mean</u>	<u>SD</u>	<u>Mean</u>	<u>SD</u>	
Age	45.7	7.2	40.2	7.0	p<0.05
Y of FTE	12.2	2.4	14.4	2.6	p<0.05
Full-scale IQ⁺	114.5	4.3	113.8	4.2	n.s.
BDI (21-item)	31.4	6.3	2.1	2.5	p<0.001
HADS (Anxiety)	14.1	3.0	2.9	2.8	p<0.001
HADS (Depression)	14.8	3.2	0.9	2.0	p<0.001
Hayling's SES	2.6	1.8	5.8	1.1	p<0.001
FAS Verbal Fluency	46.2	9.0	44.7	8.7	n.s.
Stroop % Increase RT	146.6	65.3	63.1	21.4	p<0.001
Stroop error score	4.6	3.7	1.8	2.1	p<0.05

Y of FTE= Years of full-time education completed, BDI=Beck Depression Inventory, HADS=Hospital Anxiety & Depression Scale. ⁺Estimated from participants' error score on the National Adult Reading Test. Hayling's SES = Scaled error score on section two of the Hayling's sentence completion task.

Analysis of the participants' performance on the Stroop task revealed that depressed patients were subject to significantly greater interference from the incongruent words than were the controls; $F(1, 26)=20.7$, $p<0.001$. Furthermore, the patients made significantly more colour-naming errors than did the controls; $F(1, 26)=5.9$, $p<0.05$. Analysis of the number of words produced by participants during the FAS verbal fluency task revealed no difference between the depressed patients and the controls,

$F < 1$. However, analysis of the participants' scaled error scores from section two of the Hayling's sentence completion task revealed that the patients scored significantly lower than did the controls, indicating a marked impairment in performance of this task; $F(1, 26) = 31.5$, $p < 0.001$.

6.3.2. *Emotion Recognition*

The first hypothesis predicted that the *"depressed patients would correctly recognise significantly fewer of the emotional displays than would the controls"*. Contrary to this prediction, analysis of the percentage emotional displays correctly recognised by the participants revealed that the two groups did not differ significantly, $F < 1$.

The first hypothesis also predicted that, *"depressed patients would demonstrate superior recognition of the negative emotional expressions relative to positive."* In line with this prediction there was some evidence to suggest that the two groups differed in terms of which type of emotional display they were better at identifying, evidenced by an interaction between group and the valence of the emotion displayed that approached conventional significance (illustrated in figure 6.1), $F(1, 26) = 2.6$, $p = 0.11$. Further analysis revealed that the depressed patients demonstrated better recognition of negative ($\mu = 92.0\%$, $SE = 2.4$) than positive emotional displays ($\mu = 81.5\%$, $SE = 4.2$); $t(13) = 2.0$, $p < 0.05$ (one-tailed). Furthermore, depressed individuals recognised fewer positive emotions than did the controls ($\mu = 89.3\%$, $SE = 2.4$), a difference that approached conventional significance, $t(26) = 1.6$, $p = 0.06$ (one-tailed).

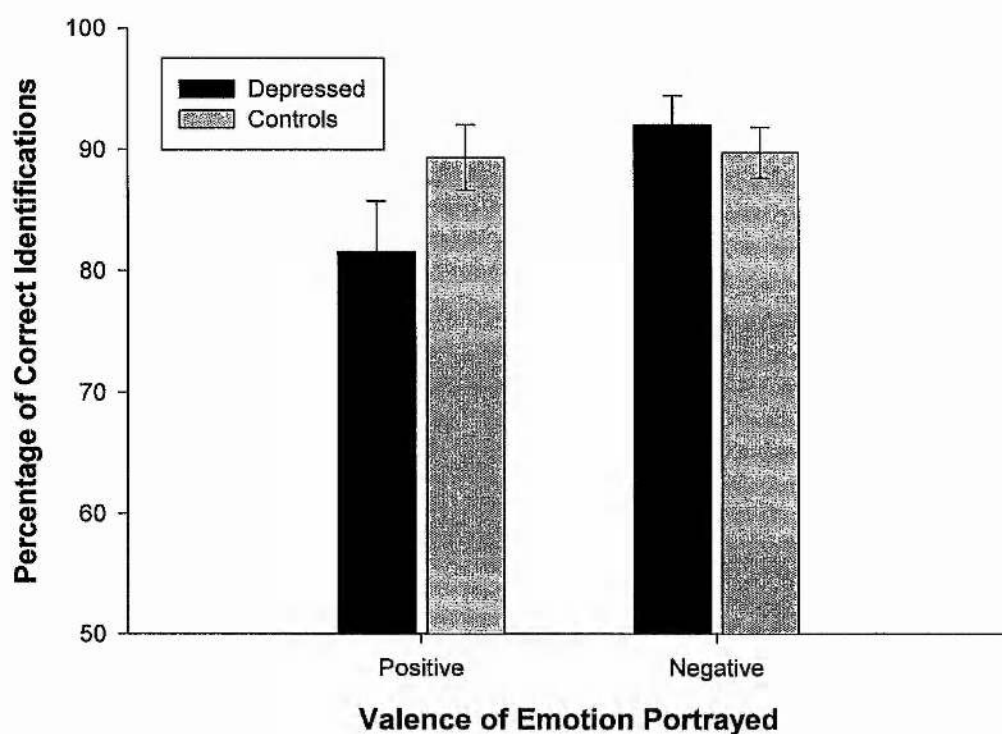


Figure 6.1. Percentage of positive and negative emotional displays correctly identified, as a function of participant group (error bars represent \pm one standard error of the mean)

In order to investigate this finding further the percentage of each type of emotional expression categorised (according to the TASIT manual) as positive will be considered. Inspection of the data presented in table 6.2 revealed that the depressed individuals appeared to exhibit poorer recognition of happiness than did the controls. An independent t-test revealed that this difference approached conventional significance; $t(26)=1.9$, $p=0.06$.

Table 6.2. Percentage of correct recognitions of each type of positive emotional expression, as a function of participant group (one standard error of the mean presented in parentheses)

Emotional Expression	Depressed (N=14)	Controls (N=14)
Happiness	78.6 % (7.8)	94.6% (2.8)
Surprise	92.9% (3.1)	91.1% (3.3)
Neutral	73.2 % (8.5)	82.1% (7.1)

6.3.3. Social Inference (Minimal)

Analysis of the percentage of sincere and sarcastic interactions correctly interpreted by the participants during the Social Inference (minimal) phase of the study revealed that the two groups did not differ significantly in terms of the overall number of interactions they correctly interpreted; $F(1, 26)=3.0$, $p>0.5$. However, the second hypothesis predicted that, "*depressed individuals would make significantly fewer correct interpretations of the sarcastic social interactions than would the controls*". In line with this prediction the main analysis revealed a significant interaction between participant group and the type of social interaction (illustrated in figure, 6.2); $F(1, 26)=4.3$, $p<0.05$.

Further analysis revealed that the depressed individuals made significantly fewer correct interpretations of the sarcastic interactions ($\mu=83.9\%$, $SE=3.1$) than did the controls ($\mu=95.9\%$, $SE=1.2$); $t(26)=3.6$, $p<0.01$. However, as expected, the two groups did not differ in terms of the percentage of sincere interactions they correctly

interpreted. Furthermore, the percentage of sincere and sarcastic interactions correctly interpreted by the depressed patients did not differ significantly. However, the controls correctly interpreted significantly more sarcastic than sincere interactions ($\mu=84.3\%$, $SE=4.2$); $t(13)=2.8$, $p<0.05$.

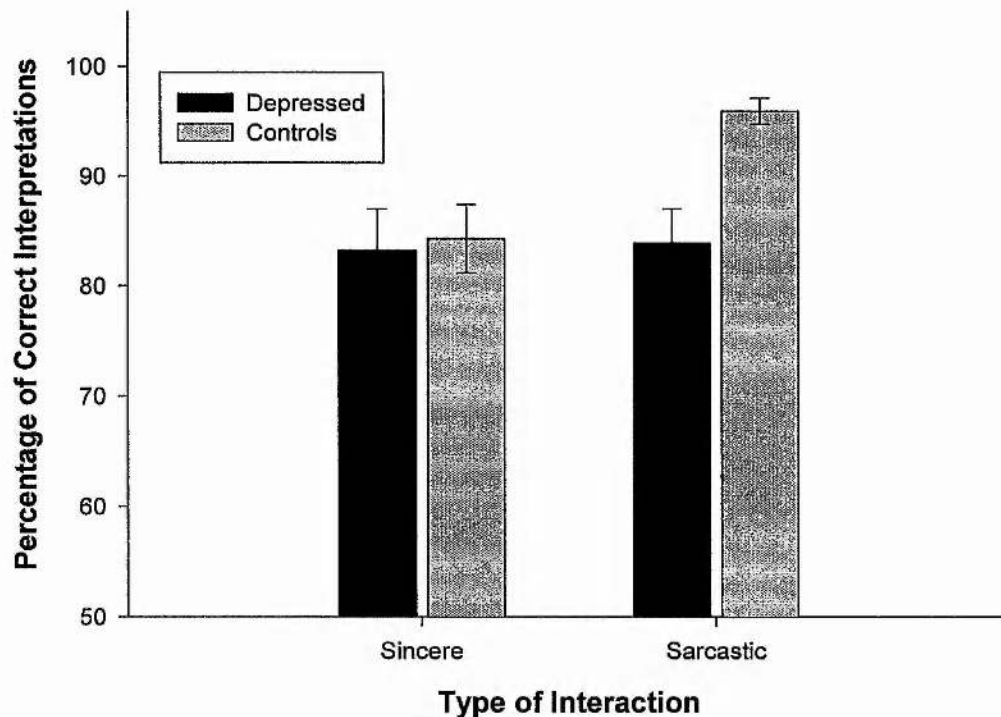


Figure 6.2. Percentage of social interactions correctly interpreted during the social inference (minimal) phase, as a function of participant group (error bars represent \pm one standard error of the mean)

6.3.4. Social Inference (Enriched)

In the third hypothesis it was predicted that, *"depressed patients would make significantly fewer correct interpretations of sarcastic interactions than would the controls"*. However, there was no evidence of the expected interaction between the type of social interaction and participant group; $F<1$. Analysis of the percentage of

each type of social interaction correctly interpreted by the participants during the Social Inference (enriched) phase revealed that, overall, depressed individuals correctly interpreted significantly fewer social interactions ($\mu=76.5\%$, $SE=2.9$) than did the controls ($\mu=89.7$, $SE=1.7$); $F(1, 26)= 11.0$, $p<0.01$.

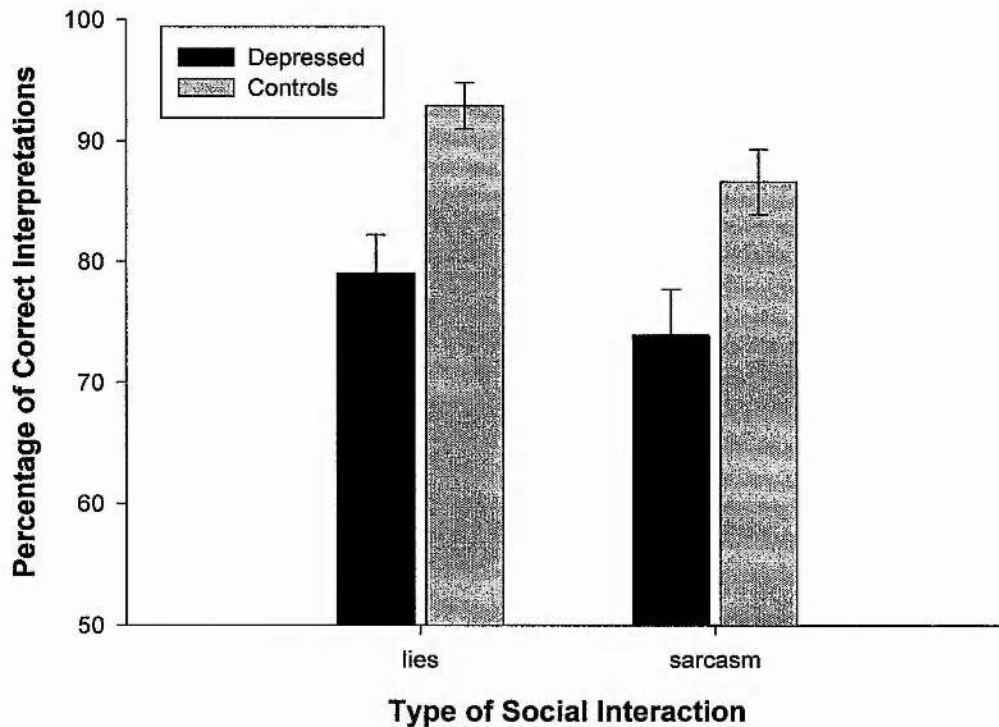


Figure 6.3. Percentage of social interactions correctly interpreted during the social inference (enriched phase), as a function of participant group (error bars represent \pm one standard error of the mean)

6.3.5. Executive Function and Interpretation of Social Interactions

6.3.5.1. Social Inference (minimal)

Pearson's correlation coefficients were calculated in order to assess if participants' ability to correctly interpret social interactions was related to their general executive function. These analyses revealed that the percentage of sarcastic interactions

correctly identified during the SIM phase was significantly positively correlated with the participants' error score on the Hayling's and significantly negatively correlated with the number of Stroop colour-naming errors; $r(27)=0.5$, $p<0.01$ and $r(27)=-0.5$, $p<0.01$ respectively. The percentage of sarcastic interactions that were correctly interpreted during the SIM phase was not significantly related to either the participants FAS verbal fluency score or the amount of interference on the Stroop task they experienced; $r(28)=-0.3$, $p>0.05$ and $r(28)=-0.3$, $p>0.05$ respectively. Pearson's correlations also revealed that the percentage of sincere social interactions correctly interpreted during the SIM phase was not significantly related to any of the executive measures; Stroop interference, Stroop error score, Hayling's error score, or FAS verbal fluency; $r(28)=0.1$, $p>0.05$, $r(28)=-0.1$, $p>0.05$, $r(28)=0.1$, $p>0.05$ and $r(28)=0.08$, $p>0.05$ respectively.

6.3.5.2. Social Inference (enriched)

Pearson's correlation coefficients were calculated in order to assess if participants' ability to correctly interpret social interactions during the SIE phase was related to their general executive function. These analyses revealed that the percentage of sarcastic interactions that were correctly interpreted during the SIE phase was significantly positively correlated with the participants' error score on the Hayling's and significantly negatively correlated with the participants Stroop interference index (% increase in colour-naming time), $r(27)=0.7$, $p<0.001$ and $r(23)=-0.4$, $p<0.05$ respectively. These analyses also revealed that the percentage of sarcastic interactions correctly interpreted during the SIE phase was not significantly related to the participants' score on the FAS verbal fluency task or the number of errors made by the participants on the Stroop task; $r(28)=-0.1$, $p>0.05$ and $r(28)=-0.29$, $p>0.05$

respectively. Pearson's correlations also revealed a positive relationship between the Hayling's error score and the number of interactions involving white lies that were correctly interpreted during the SIE phase; this relationship approached conventional significance; $r(28)=0.4$, $p=0.06$. There was also a significant negative relationship between the participants' Stroop error score and the number of interactions containing lies that they correctly interpreted during the SIE phase; $r(28)=-0.4$, $p>0.05$.

6.3.6. Depression Severity, Executive Function and Social Perception

As depression impairs both executive function (see section 1.2.4, page 9) and social processing (see section 1.4.3, page 30) it was appropriate to investigate if the influence of executive function on interpretation of social interactions reported above was related to the severity of depression being experienced by the participants. To this end, Pearson's correlation coefficients were calculated to establish if depression severity (indexed by BDI score) was related to the correct interpretation of social interactions and to participants' performance on the executive tasks. These analyses revealed that BDI score was significantly negatively correlated with the percentage of sarcastic interactions correctly interpreted by the participants during both the SIM and SIE phases; $r(28)=-0.6$, $p<0.001$ and $r(28)=-0.55$, $p>0.01$ respectively. BDI score was also significantly negatively correlated with the percentage of interactions involving lies that were correctly interpreted during the SIE phase; $r(28)=-0.7$, $p<0.001$. However, BDI score was not significantly correlated with the percentage of sincere interactions that were correctly interpreted during the SIM phase, $r(28)=-0.1$, $p>0.05$. Importantly, Pearson's correlations also revealed that depression severity (indexed by BDI score) was significantly negatively correlated with participants' Hayling's scaled error score; $r(28)=-0.7$, $p<0.001$, and significantly positively related to Stroop

interference and error scores; $r(28)=0.6$, $p<0.01$ and $r(28)=0.4$, $p<0.05$ respectively. However, BDI score was not significantly related to participants score on the FAS verbal fluency score; $r(28)=0.2$, $p>0.05$.

In order to assess the influence of depression severity on the observed relationships between executive function and interpretation of social interactions (reported in section 6.3.5, page 166) the correlation coefficients were recalculated partialing out the participants' scores on the BDI. These results revealed that, once depression severity had been controlled for, the percentage of sarcastic interactions correctly interpreted during the SIM phase was no longer significantly correlated with Hayling's error score; $r(25)=0.1$, $p>0.5$. However, a small but significant relationship was still observed between the number of errors on the Stroop task and the percentage of sarcastic interactions correctly interpreted during the SIM phase; $r(25)=-0.3$, $p<0.05$ (one tailed). These analyses also revealed that, even after controlling for depression severity, the percentage of sarcastic interactions correctly interpreted during the SIE phase was significantly correlated with the participants' error score on the Hayling's; $r(25)=0.6$, $p<0.01$. However, once depression severity was controlled for, the percentage of interactions containing lies that were correctly interpreted during the SIE phase was no longer significantly related to Hayling's error score or Stroop error score; $r(25)=-0.1$, $p>0.5$ and $r(25)=-0.2$, $p>0.05$ respectively.

6.4. Discussion

The aim of the current study was to extend the literature concerning the profile of emotion recognition and social perception that is associated with major depression. A

secondary aim was to establish if impaired comprehension of social interactions was related to deficits in executive functioning.

6.4.1. Emotion Recognition Phase

The first hypothesis predicted that *"the depressed patients would correctly recognise significantly fewer of the emotional displays than would the controls"*. This prediction was not supported by the results of the current study, as the two groups did not differ in their overall ability to recognise the emotions portrayed in the video clips. This finding corresponds very well with previous studies (e.g. Ridout et al, 2003) and suggests that depression is not associated with a general impairment of emotion recognition. However, there was some support for the second part of the first hypothesis, as depressed individuals were shown to recognise significantly more negative than positive expressions. Further inspection of these results would seem to suggest that this result was due to impaired recognition of positive emotions relative to the controls. In particular there was evidence to suggest that the depressed individuals were impaired in their recognition of happiness. These findings correspond with the pattern of mood-congruence that has been reported on a number of different cognitive tasks (e.g. autobiographical memory retrieval). Furthermore this pattern of data corresponds with the findings of Ridout et al (2003), who reported impaired recognition memory of happy faces relative to neutral expressions. However, it should be noted that in that study there was no significant evidence of impaired emotion recognition during the encoding phase. The finding, from the current study, that the depressed patients were impaired in recognising positive expressions in general, and happy expressions in particular, has implications for their ongoing depressive episode. If a depressed individual is insensitive to the happy

expressions they encounter they will perceive social encounters in a more negative light, which could reduce the positive effects social interaction and act to maintain or even worsen the episode. Furthermore, if a depressed individual fails to recognise that someone is being friendly then this could lead to misunderstandings and social tension.

6.4.2. Social Inference Minimal (SIM)

Hypothesis two predicted that *"the depressed patients would make significantly fewer correct interpretations of the sarcastic interactions than would the controls"*. This prediction was supported by the findings of the current study. Furthermore, as expected the two groups did not differ in terms of the number of correct interpretations they made of sincere interactions. These results correspond with the pattern that was observed for patients who had suffered traumatic brain injury, reported in McDonald et al (2003). It would appear that, in common with patients who have suffered TBI, depressed individuals are quite able to comprehend social interactions where the meaning is explicit, but experience difficulties understanding social exchanges where the meaning is implied. The extent to which this might relate to deficits in executive processing is discussed in section 6.4.4 below.

Interestingly, investigation of the results of the SIM phase revealed that the controls made significantly more correct interpretations of the sarcastic interactions than the, supposedly easier, sincere exchanges. This finding suggests that the observed difference between the two groups in terms of the interpretation of sarcastic interactions might be a consequence of a bias on the part of the healthy controls towards making a sarcastic inference, rather than a deficit in the interpretation of

sarcasm by the depressed individuals. If the controls exhibited a tendency towards interpretation of the interactions as being sarcastic then it would be expected that they would get more of the sarcastic interactions correct than would the patients (if these individuals were not showing such a bias). However, if they were applying this strategy it would also be expected that they would get more of the sincere interactions incorrect than would the patients, but this pattern was not observed. Importantly, inspection of the data reported by McDonald et al (2003) reveals the identical pattern. One possibility is that the control group in their study demonstrated the same tendency towards making the sarcastic inference as the controls in the current study. However, a plausible alternative is that a number of the sincere interactions may have been ambiguous in terms of their meaning and hence may have led to misinterpretations by both groups of participants. The difference in the percentage of sincere and sarcastic interactions correctly interpreted by the controls cannot be explained in terms of the sincere interactions being generally harder to interpret as the percentage of these interactions correctly identified during the SIM phase of the current study was not correlated with deficits in cognitive performance (evidenced by the participants' performance on the Stroop and Hayling's tests). Evidence that the percentage of sarcastic interactions correctly interpreted by the participants during the SIM phase of the current study is significantly correlated with both their BDI score, and with their performance on the Stroop and Hayling's tasks is suggestive that the difference in sarcastic inference is due to impairment on the part of the patients. This finding requires confirmation in the future before strong conclusions can be made. Furthermore, an explanation based on a greater tendency on the part of healthy individuals towards making a sarcastic inference also requires further investigation.

The presence of impaired social interpretation on the part of the patients would be consistent with the findings of previous studies (e.g. Ambady & Gray, 2002; Butler & Mathews, 1983; Krantz & Hammen, 1979) that have reported dysfunctional social perception in depressed individuals. It can be argued that there is at least some evidence from the current study to suggest that, relative to healthy participants, clinically depressed individuals are impaired in their comprehension of sarcasm. This finding is important, as it could have real implications for these patients in their everyday social exchanges. As outlined previously, such insensitivity could lead the patients to misunderstand the behaviour/intentions of significant others, which in turn could act to undermine these important relationships.

6.4.3. Social Inference - Enriched

The third hypothesis predicted that *"the depressed patients would make significantly fewer correct interpretations of the sarcastic interactions than would the controls"*. This hypothesis was supported. However, contrary to the predicted pattern of results the depressed patients were also impaired in their interpretation of interactions involving lies. This pattern of results does not correspond with the findings of McDonald et al (2003). During this phase of the study it appears that depressed individuals exhibited difficulties in comprehending social interactions, even when the meaning was made explicit. It is possible that the significant impairment in understanding interactions involving lies might relate to the well-reported negative bias in the depressed patients' social judgements. The majority of the social exchanges portrayed in TASIT that involve one of the protagonists lying involve the use of white lies to protect the conversational partner from the truth. For example, in one scene we see a female character (*Ruth*) talking to a male character (*Michael*)

about how she thinks that their friend (*Gary*) has put on weight. In the next scene we see Ruth insisting to Gary that he hasn't put on weight. The correct interpretation of this interaction is that Ruth is trying to be nice to her friend by playing down the truth. However, in line with previous studies (e.g. Krantz & Hammen, 1979; Butler & Mathews, 1983), it would seem plausible to assume that on some occasions at least the depressed individuals would have provided a more negative, and hence incorrect, interpretation of these interactions. The extent to which the observed impairments in social processing might relate to executive functioning will be addressed in the next section.

6.4.4. Executive Function and Interpretation of Social Interactions

As noted above the percentage of sarcastic interactions correctly interpreted by the participants during the SIM and SIE phases of TASIT was significantly related to their performance on the Hayling's and Stroop tasks. These findings provide good evidence that the 'executive' processes, particularly those involving conflict resolution and inhibition of pre-learned responses, are implicated in the successful comprehension of social exchanges that involve sarcasm. Furthermore, it appears that these processes were involved to some extent in the correct interpretation of interactions involving deception. As previous studies (e.g. Pardo et al, 1990; van Veen & Carter, 1992) have implicated the anterior cingulate (AC) region of the prefrontal cortex in the successful performance of these executive tasks, it is plausible that the observed deficits in social inference related to a disruption of normal functioning of this cortical region. Evidence for this notion comes from previous studies demonstrating that lesions to the AC are associated with impairment of emotion recognition (e.g. Hornack et al, 2003).

6.4.5. Depression Severity, Executive Function and Interpretation of Social Interactions

As noted in section 6.3.6, the percentage of sarcastic interactions correctly identified during both SIM and SIE phases of TASIT was negatively related to depression severity (indexed by the BDI). Furthermore, the participants' performance on the executive tasks (Hayling's and Stroop tasks) was also significantly related to the participants' depression severity. One plausible interpretation of these findings is that the observed deficits in social inference and executive function were both a consequence of the participants' ongoing depression. The finding that controlling for depression severity significantly reduced the strength of relationships between performance on executive tasks and correct social inference provides support for this notion. It is plausible that these deficits were a consequence of reduced cognitive capacity in the depressed patients. It is also plausible, based on previous studies (e.g. George, 1993) that these findings related to a disruption of anterior cingulate function in the depressed patients.

6.4.6. Methodological Considerations

There are a number of points that require consideration. The first is that there was a relatively small *n* in this study, which means that the findings should be treated with caution. A replication of this study with a larger *n* would be required to confirm the findings. Secondly, as TASIT is Australian (it features Australian actors with fairly strong accents) and has not been validated in this country there might be cultural differences that could influence the results (differences in voice inflection for example). However, this would be the same for both depressed patients and controls. A potential future study could involve developing a UK version of TASIT in order to

confirm the findings with culturally relevant stimuli. A further consideration was that the patients were being medicated at the time of testing. However, previous research (Thompson, 1991) has reported that the cognitive performance of depressed patients improves when they are medicated and if the drugs were impairing performance would it not be expected that there would be a general deficit not the specific impairment observed in the current study. Although an improvement on previous studies, the participants are still required to make their interpretations of the social interactions some time (approx 15 to 60 seconds) after they have viewed the scenes. The participants had to rely on their memory of the interactions to a certain extent and there is a vast literature demonstrating selective memory in depressed participants for negative material. All of the responses in TASIT are forced choice, which does not allow room for alternative explanations of the exchanges. This is necessity in the current study as it allowed the participants' social perception skills to be quantified. However, it is important that this limitation of the methodology is noted. Despite these limitations the current study represents a genuine extension of the previous literature on both emotion recognition and social perception in major depression

6.4.7. Summary and Conclusions

Relative to the healthy participants, the depressed individuals did not exhibit a general deficit in their recognition of emotion from realistic social displays. However, there was some evidence, that they exhibited a selective impairment in their recognition of positive emotional expressions, most notably of happiness. Relative to healthy participants, depressed patients exhibited significantly impaired comprehension of sarcasm, despite being unimpaired in their interpretation of sincere social exchanges. Furthermore, there is evidence from the current study that this deficit might relate to a

disruption of the 'executive' processes, particularly those involved in the detection and resolution of cognitive conflict. The finding that the patients were also significantly impaired in their interpretation of social exchanges that involved "white lies" could be a consequence of the tendency of depressed individuals to judge ambiguous social situations in an overtly negative light. Alternatively, this deficit could simply relate to depression-related reductions in available cognitive resources that could be applied to interpret the social interactions. It is plausible that the observed deficits in executive performance and social inference were a consequence of a disruption to the normal function of the anterior cingulate region of the prefrontal cortex. It is clear from the current study that depression is associated with changes in emotion recognition and social perception and that these changes could seriously impact on their lives. The relatively poor sensitivity to happy expressions, for example, could colour the patient's view of the social interactions they are involved in. Likewise, impaired comprehension of sarcasm and a tendency towards negative interpretation of ambiguous events could lead to social misunderstandings that could lead to, or increase, social discord, which in turn could act to weaken important social bonds and increase social isolation. Overall, it would seem likely that the observed biases and impairments of emotion recognition and social perception in the depressed patients could act to maintain or even worsen their ongoing depressive episode.

- CHAPTER SEVEN-

NEUROSURGERY FOR CHRONIC, TREATMENT-REFRACTORY, DEPRESSION: SUBSEQUENT IMPAIRMENT OF EMOTION RECOGNITION AND SOCIAL PERCEPTION?

7.1. Introduction

7.1.1. Background

Recent advances in the understanding of the neurobiological underpinnings of mental disorders (e.g. based on structural & functional imaging techniques), coupled with the development of more precise stereotactic neurosurgical procedures, have contributed to the relatively recent resurgence in the use of neurosurgery as a treatment option for treatment-refractory psychiatric conditions. However, the use of these interventions has been confined to patients whose psychiatric condition has been considered severely disabling and who have failed to respond to all other appropriate treatment, either physiological (e.g. antidepressant medication & ECT) or psychological (e.g. cognitive behavioural therapy) in nature. The next section of this introduction will outline the types of neurosurgical intervention for chronic mental disorders that are currently performed at Ninewells hospital in Dundee. The subsequent sections will consider the consequences of these interventions, with particular reference to potential impairments of emotional processing that might be associated with these procedures. Finally, an overview of the aims and predictions of current study will be provided.

7.1.2. Neurosurgery for Mental Disorders (NMD) in Dundee

Between 1992 and 2001 thirty-four neurosurgical procedures were performed in Dundee in an attempt to manage chronic treatment-refractory mental disorders

(Matthews & Eljamel, 2003). There are currently two different surgical interventions for mental disorders that are offered at Ninewells in Dundee; these are anterior cingulotomy and anterior capsulotomy. Anterior cingulotomy, performed to manage treatment-refractory depression (CTRD), involves bilateral thermal lesions of the anterior cingulate gyri in order to disconnect the Papez circuit (Binder & Iskandar, 2000). The anterior capsulotomy, performed to manage treatment-refractory OCD and CTRD, involves bilateral thermal lesions of the anterior limbs of the internal capsule, in order to disconnect the orbitofrontal cortex and certain limbic structures, most notably the midline thalamic nuclei and caudate nucleus (Binder & Iskandar, 2000).

7.1.3. What are the long-term consequences of neurosurgery?

The majority of follow-up studies addressing the long-term effects of neurosurgery have tended to focus mainly on the efficacy of the different procedures (see Binder & Iskandar, 2000). However, there have been a small number of studies addressing the cognitive consequences of these procedures. For example, Vasko and Kullberg (1979) reported that anterior cingulotomy was associated with impaired spatial memory in a number of patients. They also reported that capsulotomy was related to deficits in performance on tests of verbal memory. Cohen et al (1999), on the other hand, reported that cingulotomy was associated with impaired sustained attention and response production. Other studies have examined the effects of these procedures on certain personality measures. For example, Mindus et al (1999) reported deviant psychopathic traits in one capsulotomy patient on the Karolinska scales of personality.

It is clear that the majority of outcome studies that have addressed negative psychological consequences have tended to focus on general cognitive/intellectual

function. However, as the aim of both of these surgical interventions is to disrupt the functioning of areas of the prefrontal cortex and limbic system that are involved in emotional behaviour, it would seem feasible that they could also have a negative effect on patients' ability to process emotional stimuli. Evidence for this position comes from a study conducted by Happé, Malhi & Checkley (2001), who reported 'theory of mind' deficits in a patient that had undergone an anterior capsulotomy as an intervention for chronic bipolar affective disorder. The patient (PB) demonstrated impaired understanding of stories that involved references to mental states (e.g. double bluffs, persuasion or 'white lies'), relative to a psychiatric control (DR, who was also suffering from chronic bipolar disorder but who had not received surgery) and a group of matched healthy controls. Furthermore, relative to DR and the controls, PB demonstrated impaired understanding of newspaper cartoons where the humour was dependent upon what one of the featured characters mistakenly thought or did not know.

Further evidence supporting the view that these neurosurgical interventions might be associated with an impairment of social perception comes from a study conducted by Hornak, Rolls and Wade (1996), who reported that patients with ventral frontal lobe damage exhibited deficits in emotion recognition from faces and vocalisations. Similarly, Hornak et al (2003) reported that circumscribed lesions to areas of the prefrontal cortex exerted significant effects on emotion perception and behaviour. Most notably for the current study, they demonstrated that individuals with lesions to the anterior cingulate and orbito-frontal cortex were impaired in their ability to identify emotion from faces and voices.

The findings of a number of imaging studies (e.g. Calarge et al, 2003; Gallagher et al, 2000) also provide evidence that these neurosurgical procedures might be associated with changes in the ability to comprehend social information, as they have indicated a possible role for the medial frontal cortex and anterior cingulate in comprehending other's state of mind.

Despite the evidence provided above there have been very few studies addressing the possible changes in emotional processing that might be associated with these neurosurgical interventions. Therefore the aim of the current study is to provide a detailed account of the effects of circumscribed neurosurgical lesions of two important regions of the pre-frontal cortex on the patients' subsequent ability to correctly interpret important social signals.

Previous studies that have examined changes in emotional processing that are associated with neurosurgery have tended to rely on presentation of verbal tasks (e.g. stories), recorded emotional sounds (e.g. crying) or static emotional facial expressions. Furthermore, these stimuli have invariably been presented in isolation. However, as outlined in the previous chapter, in everyday social interactions protagonists are required to interpret multiple channels of information in order to make sense of the interaction. Therefore, in order to understand the true impact of these neurosurgical interventions on social functioning, it is important to assess how they influence the processing of more ecologically valid stimuli (such as videotaped social interactions). The study outlined in the previous chapter utilised a recently developed neuropsychological task (TASIT) to assess changes in emotion recognition and social perception associated with clinical depression. TASIT was developed specifically to investigate changes in emotion processing that are associated with

traumatic brain injury (TBI). Using TASIT, patients with TBI have been shown to exhibit emotion recognition deficits and also significant impairment in comprehending social interactions that involve sarcasm (MacDonald et al., 2003). Furthermore, the findings of the previous chapter demonstrate that TASIT was sensitive to changes in social perception that are associated with clinical depression. Therefore, TASIT would seem to be an ideal tool with which to conduct the proposed investigation.

One of the central findings of the previous chapter demonstrated that impaired comprehension of sarcasm was related to deficits in the participants' central executive functioning (as indexed by performance on the Stroop colour-naming and Hayling's Sentence Completion tasks). As the anterior cingulate has been implicated in normal performance on such tasks (see section 1.6, page 41), it would seem likely that patients who have received lesions to this brain region might be particularly impaired in comprehending these sarcastic social exchanges.

As noted in Mathews & Eljamel (2003), only around fifty percent of patients that undergo neurosurgery will show marked improvement in their mood, which means that a number of the surgery patients that will participate in the current study will still be depressed. Therefore, of particular interest in the current study is whether these depressed surgery patients will demonstrate greater impairment on these social processing tasks than the other patient groups.

7.1.4. Overview and Predictions

In order to establish if neurosurgical interventions for chronic, treatment-refractory, mental disorders are associated with impaired emotion recognition and social

perception a group of patients that have undergone surgery will be assessed on all three sections of TASIT. The performance of the surgery patients in the current study will be compared with that of the depressed patients and healthy controls from the study reported in the previous chapter (page 163). The following predictions were made:

7.1.4.1. Hypothesis tested during the Emotional Recognition (ER) phase:

1. It is expected that there will be a significant interaction between surgery status, depression status, and the valence of emotional displays, such that depressed surgery patients will correctly recognise significantly fewer emotional displays than will other participant groups. It is expected that this finding will be particularly strong for positive emotional displays.

7.1.4.2. Hypothesis tested during the Social Inference (Minimal; SIM & Enriched; SIE) phases:

2. It is expected that there will be a significant interaction between depression status, surgery status and type of social interaction, such that depressed surgery patients will identify fewer sarcastic interactions than will the participants in the other participant groups.

7.2. Method

7.2.1. Design

All three sections of the study that involved TASIT utilised a 2 (depression status) x 2 (surgery status) x 2 (type of social interaction) repeated measures ANOVA design. For all sections of the study, the first between participants variable was depression status (depressed or non-depressed) and the second between participants variable was surgery status (surgery or no surgery). In the Emotion Recognition (ER) phase, the

within participants variable was valence of emotional display (positive or negative). In the Social Inference-Minimal (SIM) and Social Inference- Enriched (SIE) phases the within participants variable was type of social interaction (SIM: sincere or sarcastic & SIE: lies or sarcasm). The dependent variable during the ER phase was the percentage of emotional displays correctly recognised. During the SIM and SIE phases the dependent variable was the percentage of social interactions correctly interpreted.

7.2.2. Participants

Eight individuals (2 males, 6 females) that had undergone a neurosurgical intervention for chronic, treatment-refractory mental disorder took part in the current study. Prior to surgery, seven of these patients had a primary ICD-10 diagnosis of recurrent depressive episode, one of whom also had a secondary diagnosis of obsessive-compulsive disorder (OCD). The remaining participant had a primary diagnosis of OCD and a secondary diagnosis of recurrent depressive episode. Four out of the eight surgery patients had undergone both an anterior capsulotomy and anterior cingulotomy. One patient had (at the time of testing) only undergone an anterior capsulotomy. The remaining three patients had undergone only an anterior cingulotomy. At the time of testing, four of the eight surgery patients no longer met ICD-10 criteria for major depression (or any other psychiatric disorder), whereas four were still diagnosed as suffering from a major depressive episode. The mean Hamilton rating score of the recovered group was 4 (SD=1.4), whereas the mean HRSD rating for the participants who remained depressed was 25.8 (SD=2.9). Of the four participants who were recovered at testing two had undergone both procedures and two had only undergone an anterior cingulotomy. Similarly, two of the patients

that remained depressed (at the time of testing) had undergone both procedures. Of the other two depressed patients, one had only undergone an anterior capsulotomy and the other had only undergone an anterior cingulotomy. As it was not possible to test the eight patients prior to surgery their performance on the different tasks utilised in the current study was compared with that of the clinically depressed sample ($n=14$) from the study outlined in the previous chapter (in order to establish how the surgery patients might have performed on these tasks prior to their surgery). The performance of these two clinical groups was compared to that of the healthy controls ($n=14$) from the study reported in the previous chapter (page 163). The characteristics of the individual making up the three participant groups are reported in table 7.1 (page 205). It should be noted that the findings of the current study must be treated with caution, as, due to the infrequency of these surgical procedures, the number of surgery patients that were available to participate was relatively small. This problem is particularly marked in cases where the performance of the depressed and non-depressed surgery patients is compared. According to Cohen (1992) a sample size of 18 depressed and 18 recovered surgery patients would have been required to detect a large effect size (with a power of 0.80). It is therefore clear that this element of the current study was underpowered (full details of these power analyses can be found in appendix II).

7.2.3. Materials and Apparatus

This study made use of the identical materials and apparatus that were utilised to conduct the study outlined in the previous chapter (page 171).

7.2.4. Procedure

Participants were assessed following the identical procedure to that used to conduct the study outlined in the previous chapter (page 174)

7.2.5. Data Analysis

A MANOVA was conducted to establish if the three groups differed significantly in terms of age, educational background (years of full-time education), general intellectual ability (estimated from the NART error score), verbal fluency, scaled error score on section two of the Hayling's sentence completion task, Stroop interference index (% increase in colour-naming time from control to experimental condition), number of Stroop errors, and self-rated mood (indexed by their scores on the BDI and HADS). The percentage of emotional displays correctly recognised during the Emotion Recognition phase of TASIT was analysed using a 2 (depressed/non-depressed) x 2 (surgery/no surgery) x 2 (positive/negative) repeated measures ANOVA. The percentage of correct interpretations of the social interactions made by the participants during the Social Inference Minimal phase was analysed using 2 (depressed/ non-depressed) x 2 (surgery/no surgery) x 2 (sincere/sarcastic) ANOVA. A further 2 (depressed/ non-depressed) x 2 (surgery/ no surgery) x 2 (lies/sarcasm) ANOVA was used to analyse the percentage of correct interpretations made by the participants during the Social Inference – Enriched phase. Subsequent pair-wise comparisons were made using Least Significant Difference tests where a-priori predictions were made and Bonferroni tests where no such predictions had been made. Significant interactions were investigated using one-way and two-way ANOVA and t-tests (paired & independent), with alpha adjusted where appropriate.

7.3. Results

7.3.1. *Participant Characteristics*

Analysis of the data (presented in table 7.1) revealed that the three groups did not differ significantly in terms of their educational background (years of full-time education completed) and their general intellectual ability (estimated from the number of reading errors on the NART); $F(2, 29)=2.7$, $p>0.05$ and $F<1$ respectively. However, this analysis revealed that the groups differed significantly in terms of age; $F(2, 29)=3.4$, $p<0.05$. Further analysis revealed that the age of the surgery patients did not differ significantly from that of the controls but the depressed patients were significantly older than the surgery patients, $p<0.05$. Therefore, age was controlled for in all subsequent analyses using ANCOVA, with age entered as a covariate.

As expected, the groups differed significantly in terms of their self-rated depression on both the BDI and the HADS depression subscale; $F(2, 29)=33.2$, $p<0.001$ and $F(2, 29)=35.3$, $p<0.001$. Subsequent analysis revealed that the surgery patients did not differ significantly from the depressed patients on the BDI or HADS depression subscale, both tests $p>0.05$. However, they rated themselves as significantly more depressed on both the BDI and the HADS than did the controls, $p<0.001$ and $p<0.01$. Also, analysis of the Hamilton ratings provided by the clinicians (or in some cases by the author) for the depressed and surgery patients revealed that the depressed sample were rated as being significantly more depressed than were the surgery patients; $t(20)=2.2$, $p<0.05$. As expected, the three groups also differed significantly in terms of their self-rated anxiety (indexed by the HADS anxiety subscale), $F(2, 29)=36.3$, $p<0.001$. Further analysis revealed that the surgery patients rated themselves a

significantly more anxious than did the controls, $p < 0.001$. However, they rated themselves as significantly less anxious than did the depressed patients, $p < 0.05$.

Table 7.1. Profile of the participants in the three groups

Participant	Surgery Patients		Depressed		Controls		P-Value
Characteristic	(N=8)		(N=14)		(N=14)		
	<u>Mean</u>	<u>SD</u>	<u>Mean</u>	<u>SD</u>	<u>Mean</u>	<u>SD</u>	
Age	39.3	4.9	45.7	7.2	40.2	7.0	<0.05
Y_FTE	13.9	2.5	12.2	2.4	14.4	2.6	n.s.
IQ ⁺	117	3.5	114.5	4.3	113.8	4.2	n.s.
HRSD	14.9	11.9	21.9	2.9	-	-	<0.05
BDI	26.0	24.0	31.4	6.3	2.1	2.5	<0.001
HADS_A	8.6	6.0	14.1	3.0	2.9	2.8	<0.001
HADS_D	9.4	8.5	14.7	3.1	0.9	2.0	<0.001
FAS	39.8	5.8	46.2	2.4	44.1	8.6	n.s.
H_SES	3.3	2.0	2.6	1.8	5.8	1.1	<0.001
Stroop Errors	7.0	6.5	4.6	3.7	1.8	2.1	<0.05
Stroop % Inc CNT	99.1	73.1	146.6	65.3	63.1	21.4	<0.01

Y_FTE= Years of full-time education completed, HRSD= Hamilton Rating Scale for Depression, BDI= Beck Depression Inventory, HADS_A= Hospital Anxiety and Depression Scale (anxiety subscale), HADS_D= Hospital Anxiety and Depression Scale (depression subscale), FAS= Verbal Fluency Task, H_SES= Scaled Error Score from Hayling's Sentence Completion Task (section two) and Stroop % Inc CNT=Percentage increase in colour-naming time. ⁺Estimated from the number of reading errors on the NART

Analysis of the data presented in table 7.1 also revealed that the three groups differed significantly on their performance on the traditional Stroop task, both in terms of the interference index (% increase in colour-naming time) and the number of colour-naming errors; $F(2, 29)=9.2$, $p<0.01$ and $F(2, 29)=4.2$, $p<0.05$ respectively. Subsequent analyses revealed that the Stroop interference index of the surgery patients did not differ from that of the depressed patients or the controls, both tests $p>0.05$. Further analysis revealed that the surgery patients made significantly more colour-naming errors than did the controls, $p<0.05$. However, they did not differ significantly from the depressed patients in terms of the number of colour-naming errors they committed, $p>0.05$. The main analysis also revealed that the participants differed significantly on their performance on section two of the Hayling's sentence completion task (indexed by the scaled error score); $F(2, 29)=14.4$, $p<0.001$. Further analyses revealed that the surgery patients were significantly impaired on this task relative to the controls, $p<0.001$. However, their performance did not differ significantly from that of the depressed patients, $p>0.05$.

7.3.2. Emotion Recognition

It was expected that during the emotion recognition phase *"there would be a significant interaction between surgery status, depression status, and the valence of emotional displays, such that depressed surgery patients would correctly recognise significantly fewer emotional displays than would other participant groups. It was expected that this finding would be particularly strong for positive emotional displays"*.

Table 7.2. Percentage of positive and negative emotional displays correctly recognised, as a function of depression and surgery status

<u>Depression Status</u>	<u>Surgery</u>	<u>Positive</u>		<u>Negative</u>	
		<u>Mean</u>	<u>SE</u>	<u>Mean</u>	<u>SE</u>
Depressed	Yes	77.1%	8.6	81.3%	8.1
	No	81.5%	4.2	92.0%	2.4
Non-depressed	Yes	83.3%	5.9	79.7%	2.1
	No	89.3	2.7	89.7%	2.3

Contrary to this prediction, there was no significant interaction between depression status, surgery status and valence; $F < 1$. However, analysis of the percentage of correctly recognised emotional displays did reveal a significant main effect of surgery status; $F(1, 31) = 5.0$, $p < 0.05$. Overall, patients that had undergone surgery correctly recognised significantly fewer of the emotional displays ($\mu = 80.3\%$, $SE = 4.5$) than did participants who not had surgery ($\mu = 88.1\%$, $SE = 1.4$). Importantly, there was no significant interaction between depression status and surgery status in terms of the number of correctly recognised emotional displays, $F < 1$.

7.3.3. Social Inference – Minimal (SIM)

During the SIM phase it was expected that *“there would be a significant interaction between depression status, surgery status and type of social interaction, such that depressed surgery patients would identify fewer sarcastic interactions than would the participants in the other participant groups”*. In line with this prediction, analysis of the data presented in table 7.3 revealed the expected significant interaction between depression status, surgery status and the type of social interaction; $F(1, 31) = 5.3$,

$p < 0.05$. In line with this prediction, analysis of the data presented in table 7.3 revealed the expected significant interaction between depression status, surgery status and the type of social interaction; $F(1, 31) = 5.3$, $p < 0.05$.

Table 7.3. Percentage of sincere and sarcastic interactions correctly interpreted by the participants, as a function of depression and surgery status

		Sincere		Sarcastic	
<u>Depression Status</u>	<u>Surgery</u>	<u>Mean</u>	<u>SE</u>	<u>Mean</u>	<u>SE</u>
Depressed	Yes	61.3%	8.3	87.5%	2.3
	No	83.2%	3.8	83.9%	3.1
Non-Depressed	Yes	71.3%	14.7	81.3%	5.5
	No	81.4%	4.6	95.9%	1.2

In order to elucidate the nature of this three-way interaction the percentage of correctly interpreted sincere and sarcastic interactions were analysed separately using 2 (depressed & non depressed) x 2 (surgery & no surgery) between participants ANOVA.

Analysis of the percentage of correctly interpreted sarcastic interactions revealed a significant depression status x surgery status interaction (illustrated in figure 7.1); $F(1, 31) = 6.5$, $p < 0.05$. Further analysis revealed that participants that were not depressed and had not undergone surgery correctly interpreted significantly more of the sarcastic interactions than did non-depressed surgery patients, depressed patients that had not had surgery, and depressed surgery patients; $t(16) = 4.1$, $p < 0.01$; $t(26) = 3.6$, $p < 0.01$ and

$t(16)=3.2$, $p<0.01$. However, the percentage of sarcastic interactions correctly interpreted by the different patient groups did not differ significantly.

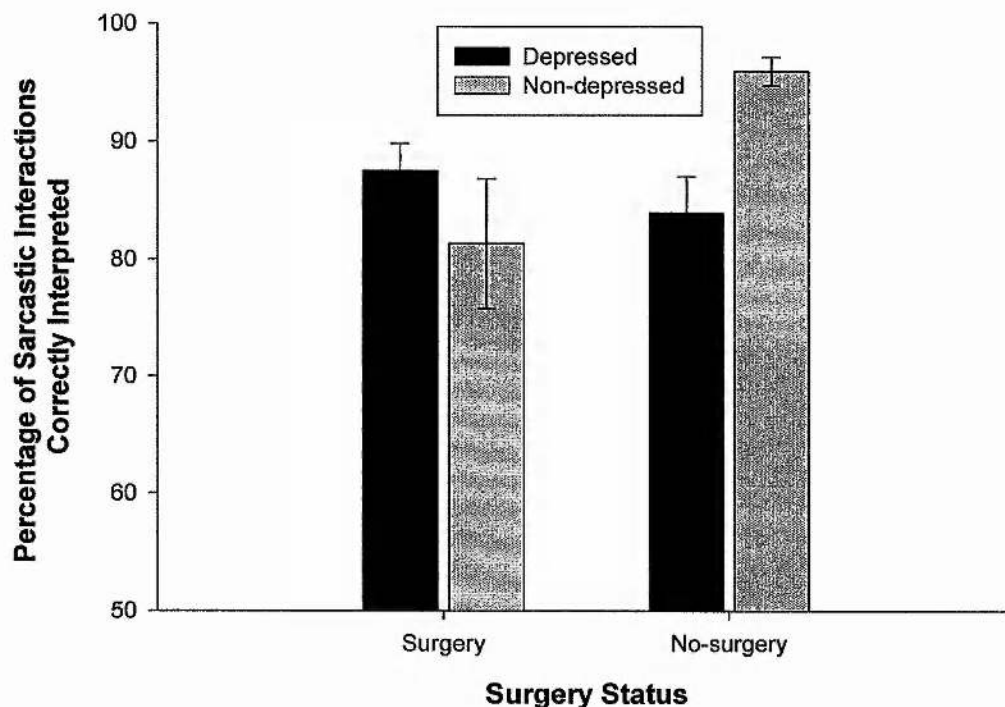


Figure 7.1. Percentage of sarcastic interactions correctly interpreted by the participants during the SIM phase, as a function of their depression and surgery status (error bars represent \pm one standard error of the mean).

Analysis of the percentage of sincere interactions correctly interpreted by the participants during the SIM phase revealed a significant main effect of surgery status; $F(1, 32)=6.5$, $p<0.05$. Overall, participants that had undergone surgery correctly interpreted significantly fewer sincere interactions ($\mu=66.3\%$, $SE=8.1$) than did participants that had not undergone surgery ($\mu=83.8\%$, $SE=2.8$). There were no other significant main effects and the depression status \times surgery status interaction was not significant, $F<1$.

7.3.4. Social Inference- Enriched (SIE)

During the SIE phase it was expected that *"there would be a significant interaction between depression status, surgery status and type of social interaction, such that depressed surgery patients would identify fewer sarcastic interactions than would the participants in the other participant groups"* However, the expected interaction between depression status, surgery status and type of social interaction was not significant; $F(1, 31)=1.5$, $p>0.05$. Analysis of the data presented in table 7.4 revealed that, during the SIE phase, patients that had undergone surgery exhibited a non-significant trend towards poorer interpretation of the social interactions ($\mu=76.8\%$, $SE=4.4$) than participants that had not undergone surgery ($\mu=83.1\%$, $SE=2.1$); $F(1, 31)=2.7$, $p=0.11$.

Table 7.4. Percentage of social interactions correctly interpreted by the participants during the SIE phase of the study, as a function of depression and surgery status

		Lies		Sarcastic	
<u>Depression Status</u>	<u>Surgery</u>	<u>Mean</u>	<u>SE</u>	<u>Mean</u>	<u>SE</u>
Depressed	Yes	74.2%	9.5	75.0%	3.4
	No	79.0%	3.2	73.9%	3.8
Non-Depressed	Yes	85.9%	4.9	71.9%	9.3
	No	92.9%	1.9	86.6%	2.7

7.4. Discussion

The aim of the current study was to establish if neurosurgical intervention for chronic, treatment-refractory mental disorders is associated with subsequent impairments of emotion recognition and social perception. Of particular interest was whether patients who had undergone surgery and that were still depressed would be particularly impaired on these social processing tasks.

7.4.1. Emotion Recognition Phase

The expectation that surgery patients that remained depressed would demonstrate greater impairment on the emotion recognition task than would the other patient groups was not supported by the results of the current study. However, analysis of the emotion recognition data did reveal that patients that had undergone surgery correctly recognised significantly fewer emotional displays than did the participants that had not undergone neurosurgery. This result corresponds with the pattern demonstrated by the brain-injured patients in MacDonald et al (2003). Furthermore, this finding is consistent with Hornak et al (2003) who reported that circumscribed lesions of both the orbito-frontal cortex and the anterior cingulate were associated with impaired identification of emotion from static facial expressions and audio-taped emotional sounds. These findings provide support for the proposition that the orbito-frontal cortex and the anterior cingulate perform an important role in the recognition of emotion from important social cues. The general impairment of emotion recognition exhibited by the surgery patients has clear implications for these patients in terms of their social interactions. Relative insensitivity to the emotional signals of other people could lead to misunderstandings that could act to cause interpersonal tension and possibly social isolation.

7.4.2. *Social Inference Minimal (SIM)*

The expectation that depressed surgery patients would identify fewer sarcastic interactions than would the other patients was not supported by the results of the SIM phase of the current study. Unsurprisingly, participants that were not depressed and had not had surgery demonstrated superior comprehension of the sarcastic interactions than did any of the patient groups. On the other hand, there were no significant differences between the different patient groups in terms of their ability to correctly interpret sarcasm. Importantly, the current findings suggest that although both depression and neurosurgery alone might impair comprehension of sarcastic interactions their effects do not appear to combine to further impair performance. The findings that surgery patients were impaired in their understanding of sarcasm corresponds with the pattern of social perception reported by McDonald et al (2003) for patients that had suffered traumatic brain injury. Notably, these findings are consistent with the pattern reported in the previous chapter for the clinically depressed patients and provide support for the notion that impaired understanding of sarcasm might relate to a disruption of the attentional processes that are thought to involve the anterior cingulate.

Contrary to expectations, surgery patients also demonstrated impaired interpretation of sincere interactions. This finding does not correspond with the findings of MacDonald et al (2003) as they reported that patients with TBI were selectively impaired on the sarcastic interactions and did not differ from the controls on the sincere interactions. It is possible that this general deficit in comprehension of social interactions could relate to a general impairment of cognitive function. However, inspection of the participants characteristics presented in table 7.1 revealed that the

surgery patients did not differ from either group in terms of their pre-morbid IQ, or educational background. Furthermore, they did not differ from the other two groups in terms of their performance on the verbal fluency task, suggesting that there was no general impairment of executive function. The surgery patients were impaired on a number of cognitive tasks (namely the Stroop and Hayling's sentence completion task), relative to the healthy controls, but importantly their performance was indistinguishable from that of the depressed group. This pattern of general impairment of comprehension of social interactions is consistent with the broad-based deficit in emotion recognition that was observed in these patients during the ER phase of the current study. It is plausible that the process of comprehending social exchanges involves the same brain regions as the relatively more simple process of emotion recognition. The wide-ranging deficit in 'reading' social cues exhibited by the surgery patients in the current study has clear implications in terms of their ability to conduct successful social exchanges.

7.4.3. Social Inference Enriched (SIE)

There was no support for the expectation that depressed surgery patients would demonstrate greater impairment on this task than would the other patient groups. Inspection of the evidence from the SIE phase revealed that, in line with their performance on the ER and SIM phases, the surgery patients exhibited a general deficit in comprehending the social interactions. Again these findings are not consistent with the pattern reported in McDonald et al (2003) for patients with traumatic brain injury. It is possible that these findings represent a general cognitive deficit or a greater error-proneness in these patients relative to the healthy non-depressed controls. However, as noted previously the groups were matched for pre-

morbid IQ and educational background. Furthermore, they did not differ from the controls in terms of their performance on the verbal fluency task, which suggests that the patients were not subject to a general executive deficit. This finding also creates doubt in terms of an explanation based on lack of motivation, as the verbal fluency task is sensitive to differences in motivation. However, as noted in the previous section, a general inability to comprehend the emotional signals of others could have a negative impact on the social functioning of these patients, and could represent a possible risk factor for future depression as it is feasible that impaired social functioning in these patients could result in social isolation.

7.4.4. Methodological Considerations

There are a number of factors from the current study that require consideration. The first and most important is the small number of surgery patients that were included in this study. Due to the relative infrequency of these procedures it was not possible to recruit more participants. For this reason the findings of the current study must be treated with some caution. This is particularly true when the difference between depressed and non-depressed surgery patients is considered, as this represented the difference between two groups of four patients. Another factor that needs to be considered is that the depressive episode suffered by the participants making up the psychiatric control group may not have been as severe as that of the patients that had required neurosurgery. A further consideration is that the surgery group contained participants that had undergone a variety of interventions (anterior cingulotomy, anterior capsulotomy and in half the cases both procedures). Possible weaknesses concerning TASIT were discussed in the previous chapter. It would appear that neurosurgery is associated with a general impairment in social perception. However,

these findings require replication with a larger sample in order to confirm them and for stronger conclusions to be made.

7.4.5. Summary and Conclusions

Overall, patients that had undergone a neurosurgical intervention for a chronic, treatment-refractory, mental disorder were significantly impaired in their ability to recognise the basic emotions from realistic portrayals of simple social interactions. This finding is consistent with Hornak et al (2003) who reported emotion recognition deficits in patients that have undergone circumscribed lesions to the anterior cingulate and orbitofrontal cortex. Notably, patients who had undergone neurosurgery and remained depressed did not demonstrate a greater impairment in emotion recognition than the other patient groups. Evidence from the social inference phases of TASIT (minimal & enriched) revealed that patients who had undergone surgery demonstrated a general impairment in their ability to interpret social interactions relative to participants who had not undergone neurosurgery. These findings do not correspond with McDonald et al (2003), who reported that patients with traumatic brain injury were selectively impaired in their interpretation of sarcasm. It is plausible that these findings relate to a disruption of the processes involved in conflict resolution and inhibition of pre-learned responses, as proposed in the previous chapter. It is clear that the general impairment in social perception demonstrated by the surgery patients could have a negative impact on their social functioning and could lead to misunderstandings and conflict with significant others, which in turn could result in a loss of social support, as well as contribute to feelings of social isolation. These consequences could represent a risk factor for future episodes or could worsen the depression of the patients who had remained depressed.

- CHAPTER EIGHT -

GENERAL DISCUSSION

8.1. Overview

As outlined in chapter one, it has been demonstrated consistently that major depression is associated with marked changes in many domains of emotional processing, most notably explicit memory for depression-relevant affective material. The main aim of this thesis was to expand upon the existing knowledge base in the area of emotional processing in major depression. In particular the aim was to continue with the avenue of research initiated in the study conducted by Ridout et al (2003) that addressed the profile of cognitive processing exhibited by clinically depressed individuals in response to important non-verbal social stimuli; namely emotional facial expressions. This approach represents an extension to previous work, as prior studies have tended to focus on depressed individuals' processing of affective verbal material (words, stories etc). It was proposed (see section 1.7, page 39) that the profile of emotional processing associated with non-verbal stimuli (faces, images etc) might differ from the pattern that is related to processing of affective verbal stimuli. This proposition was based on the assumption that the non-verbal stimuli would be more emotive than would the affective words. According to Teasdale and Barnard's ICS model (1993), mood-congruent biases in depression are only present under circumstances that result in the affect-related "hot" elements of the emotional stimuli being represented in the cognitive system, and in the case of MCM biases subsequent access to these "hot" representations is required. With this in mind, it would be expected that more emotive stimuli would result in stronger mood congruent effects. In line with this notion, Power and Dalgleish (1997) suggested that the processing of

emotional facial expressions might be more sensitive to attentional bias in depressed individuals than verbal stimuli. However, a further aim of the current body of work was to consider the pattern of emotional processing exhibited by depressed individuals in light of the general cognitive dysfunction that has been reported in the literature, as this type of consideration has been lacking in the literature. The following sections (8.2, 8.3 & 8.4) of this chapter will consider the contribution of the thesis to the current understanding of changes in selective attention, memory function and emotion recognition/social processing that are associated with major depression. The subsequent section (8.5) will consider these findings in light of the different cognitive models/theories, in an attempt to establish the possible cognitive mechanisms underlying the observed profile of emotional processing. Section 8.6 will highlight the importance of executive processes in emotional processing. Section 8.7 will consider the possible neural underpinnings of these changes in emotional processing. Section 8.8 will outline the implications of the findings in terms of the everyday function of depressed individuals and the maintenance of their current depressive episode. Section 8.9 will consider general limitations of the studies reported in the thesis. Future directions for this work will be considered in section 8.10 and, finally, section 8.11 will take the form of a summary of the contribution of the thesis to the current knowledge of emotional processing in major depression.

8.2. Selective attention for emotional material in major depression

As noted in the introduction to this thesis (section 1.4.2, page 26) evidence that depressed individuals selectively attend to depression-relevant elements of the stimulus environment is equivocal at best. However, there have been a number of studies, particularly those that have utilised the emotional version of the Stroop

colour-naming task (e.g. Gotlib & Cane, 1987), that have demonstrated that depressed individuals may, under certain circumstances, demonstrate biased attention for depression-relevant stimuli. Furthermore, other studies have demonstrated that depressed individuals fail to exhibit the positive attention bias in that is characteristic of healthy mood, which can also be interpreted as evidence of a negative bias in depressed individuals' attentional processing (as suggested by Power & Dalgleish, 1997). The study reported in chapter three of this thesis (page, 52) extended this work by utilising a face-word variant of the emotional Stroop task to investigate if clinically depressed individuals selectively processed emotional faces and affective words. This task had been used successfully by Stenberg et al (1998) to conduct a similar study in healthy adults. Their study reported that the participants exhibited a general positive word identification advantage that was enhanced when the words were presented with happy faces and abolished in the presence of sad faces. They interpreted their results as evidence that the faces were processed automatically for emotional valence and that this automatic access to emotional valence interfered with the valence identification of the affective words that were presented concurrently. It was expected that depressed individuals in the current study would demonstrate the opposite pattern to that shown by the healthy adults in Stenberg et al's study, i.e. a negative word identification advantage that would be enhanced by the presence of sad faces and abolished in the presence of happy faces. Furthermore, in the current study, a set of neutral words was also included and superimposed across happy, sad and neutral faces in order to establish if depressed individuals would demonstrate a selective attention bias for the sad faces (evidenced by slowed neutral word identification times in the presence of sad faces). The findings of the current study (pages 70-79) did not support these expectations. Overall, depressed individuals' valence identification

times were slowed when the words were paired with incongruent faces (e.g. a positive word paired with a sad face). This finding is consistent with previous studies demonstrating that clinical depression is associated with impaired inhibition of distracting information (e.g. Lamelin et al, 1997; MacQueen et al, 1999). The depressed patients did not demonstrate slower neutral word identification in the presence of sad faces, suggesting that the depressed individuals did not exhibit a selective attention bias for the sad faces. In contrast, the controls demonstrated slower neutral word identification in the presence of happy faces, suggesting their attention was being captured by the happy expressions. In line with Power and Dalgleish (1997) these findings can be interpreted as evidence of a negative attention bias on the part of the depressed patients, as they failed to selectively attend to the happy expressions. These findings will be considered further in section 8.5 when the current results are discussed in light of the different cognitive models.

8.3. Memory function and major depression

8.3.1. Memory for affective material in major depression

As reported in the introduction (section 1.4.1.2, page 22) numerous studies have reported that depressed individuals demonstrate superior memory for self-referent depression-relevant words relative to material of neutral or positive valence. However, all of these studies have presented the to-be-remembered stimuli in isolation, which is in contrast to everyday processing where multiple sources of stimuli may be present concurrently. Therefore, the experiment reported in chapter three (page 52) extended this work by establishing if the robust MCM bias was still observed when distracting information was presented concurrently with the to-be-remembered stimuli during the encoding phase. The reported findings (page 80)

suggested that the presence of the distracting information at encoding disrupted the preferential processing of depression-relevant material by the depressed patients. In contrast, the presence of distracting material at encoding appeared to have exerted a lesser effect on the processing of the controls, as there was still evidence of the expected positive memory bias exhibited by these participants. However, it should be noted that signal detection analysis suggested that this finding related to increased false recognition of positive words in the control group rather than superior 'pure' memory for these words. It is plausible that the controls were relying on a feeling of familiarity, often referred to as 'knowing', when making their recognition judgements rather than actually remembering the previous presentation of the words, which could be tested in future using the 'remember-know paradigm' (Gardiner & Java, 1993). These findings will be discussed in more detail in section 8.5 in the light of the different cognitive theories of depression.

In a previous study, Ridout et al (2003) demonstrated that the MCM bias for depression-relevant words that had been demonstrated consistently in depressed individuals generalised to their processing of sad emotional faces. The experiment reported in chapter five of this thesis (page, 125) extended this work by assessing if direct processing of the emotional valence of the faces was required at encoding for this MCM bias to be observed at memory testing. To this end, the encoding task (emotion identification) that was utilised in the original study was replaced with a task (gender identification) that did not require active processing of the emotional content of the faces. The findings of this study (page 139) demonstrated that there was no evidence of the MCM bias for sad faces in the depressed participants and no evidence of a MCM bias for happy faces in the control group, both of which suggests that

explicit processing of the emotional content of the stimuli is a prerequisite for mood-congruent retrieval to occur. Interestingly, although the controls did not demonstrate preferential memory for any particular type of facial expression (i.e. they recognised a similar percentage of happy, sad & neutral expressions), they did recognise more sad faces than did the depressed patients. This finding is not consistent with the results of Ridout et al (2003), who reported the opposite pattern of data. These finding will be discussed later in the light of the different cognitive models (see section 8.5).

A further contribution of the thesis to the understanding of memory for experimental materials in major depression was to directly investigate the extent to which depressed individuals might be susceptible to falsely recognising negative stimuli. Based on the proposal of Segal et al (1995) that depression-relevant concepts are highly organised in the cognitive systems of depressed individuals it was expected that viewing a series of depression-relevant words would lead the depressed participants in the current study to falsely recognise highly related depression-relevant words that were not presented at encoding. The findings of the study outlined in chapter three (page 84) provided some evidence for this proposal as the depressed patients exhibited a strong tendency to falsely recognise depression-relevant words that were not presented during the encoding phase but that were highly related to the words that were presented. It should be noted that this was not a general tendency on the part of the depressed patients, as they did not exhibit false memory for the highly related positive words. This finding suggests that depression-relevant 'lures' were primed in the depressed patients. These findings will be considered further in section 8.5 when the current results are discussed in light of the different cognitive models.

8.3.2. Autobiographical memory retrieval in MD

As noted in the introduction of this thesis (section 1.4.1.1, page 16) major depression is associated with marked changes to autobiographical memory function. For example, it has been reported consistently that major depression is associated with impaired access to positive memories (evidenced by slower retrieval times for these memories). A further robust finding of particular note is that, when requested to provide specific autobiographical memories (ABMs), depressed individuals tend to retrieve overgeneral, categorical memories. The study reported in chapter four of this thesis (page, 90) extended this work by establishing the pattern of ABM retrieval that is associated with healthy and depressed mood in response to important non-verbal memory cues (affective images & emotional faces). This study was based on the findings of Williams et al (1999), who reported that, compared to word cues that were low in imageability, highly imageable word cues provided greater access to specific ABMs (evidenced by faster retrieval times and retrieval of a greater proportion of specific ABMs as a first response to the cues). In line with Williams et al (1999) the current study demonstrated that visual images were associated with greater specificity of ABM retrieval than were words or faces. However, this finding was only observed in the healthy controls, as depressed individuals failed to demonstrate enhanced retrieval of specific ABMs to images cues. This finding is consistent with Williams and Dritschel (1988), who reported that depressed individuals were not able to make use of additional contextual information to enhance their access to specific ABMs.

Another finding of particular note observed in the current study, was that when the faces were used to cue ABMs depressed individuals demonstrated even greater impairment of ABM retrieval than they exhibited to words or images. Further analysis

revealed that this reduction in specificity was related to a marked increase in categorical retrieval in the face condition compared to the other cueing conditions. Content analysis of the memories retrieved by the participants provided some evidence to suggest that the increase in categorical retrieval by the depressed patients may have, at least in part, been related to induced rumination in these individuals in response to the face cues. However, the finding that depressed individuals' retrieval was significantly slower in the face condition than in the conditions cued with images or words also suggests that ABM retrieval to face cues may have required greater cognitive resources than retrieval to the other types of cue. It would be expected from previous research (e.g. Ellis & Ashbrook, 1988) that such increased cognitive demand would have disproportionately affected the depressed patients relative to the controls, as it has been suggested that major depression is associated with reduced cognitive capacity. Another finding, from the current study, that is of particular note is that depressed individuals exhibited a bias towards superior access to specific positive rather than negative ABMs. Interestingly this was only demonstrated in the percentage of specific ABMs retrieved as a first response. The pattern of retrieval times observed was consistent with previous findings, as they demonstrated that depressed individuals were quicker to access negative than positive memories. However, the finding that the depressed patients retrieved fewer specific negative than positive ABMs is inconsistent with previous studies that have generally reported the opposite pattern of retrieval. These findings will be considered further in section 8.5 in light of the different cognitive models.

8.4. Emotion recognition and social perception in major depression

8.4.1. Emotion recognition and MD

Previous research outlined in the introduction (see section 1.4.3, page 30) has demonstrated that major depression is associated with changes in the recognition of emotion from static photographs of facial expressions. The study reported in chapter six of this thesis (page, 146) extended this research by assessing depressed individuals' recognition of the seven basic emotions from video taped presentations of dynamic social displays. The findings of the current study (see page 163) revealed that, overall, depressed individuals were not significantly impaired in their ability to identify the primary emotions. However, they did demonstrate a specific impairment in terms of recognising happiness in the dynamic social displays. This finding is consistent with Bouhuys et al (1995), who reported that depressed patients perceived less happiness even in explicit displays of happiness.

In a previous study, Murphy et al (1999) reported that depressed individuals more sensitive to detecting depression-relevant words (evidenced by faster valence identification times). The findings of the experiment reported in chapter three of this thesis (page, 70) failed to replicate this finding. However, during that study there was evidence that the depressed patients were more accurate in their identification of negative words, relative to positive or neutral words (i.e. they made fewer identification errors). The failure to observe a negative word advantage in the depressed individuals' valence identification times was probably due to the inability of the patients to inhibit the faces that were presented concurrently with the words. The negative word advantage in the accuracy of valence identifications reported

above possibly related to the depressed patients' relative expertise in processing verbal material that relates to depression.

8.4.2. Social perception and MD

Previous research (see section 1.4.3, page 30) has demonstrated that major depression is associated with impaired social judgement. However, these studies have tended to involve interpretation of verbal descriptions or static drawings of social situations. The study reported in chapter six of this thesis (page, 146) extended this previous research, as it assessed depressed individuals' interpretation of videotaped depictions of 'realistic' social interactions. Evidence from this study (page, 165) revealed that depressed individuals did not demonstrate a general impairment in their ability to correctly interpret social interactions. However, these results did provide evidence that depressed patients exhibited impaired understanding of certain types of social interactions; most notably where the meaning of the interaction has to be implied, e.g. when one of the protagonists in the scenes was being sarcastic. Further investigation of these findings demonstrated that impaired interpretation of sarcastic interactions was strongly related to deficits in the participants' executive function (see pages 167-68). Another important factor affecting correct interpretation of sarcastic interactions was depression severity; individuals with higher BDI scores were shown to exhibit poorer social perception. It is clear that the social interactions that required the meaning to be inferred required a greater processing capacity, so it is likely that the observed impairments in social perception relate to a depression-related deficit in executive functioning due to a reduction in cognitive capacity in these patients. A further finding of note (reported in chapter six, page 172) was that depressed individuals exhibited deficits in correctly interpreting social interactions that involved

one of the protagonists telling a 'white' lie. As argued in chapter six, it is plausible that this finding relates to the well-reported tendency of depressed individuals to interpret ambiguous situations in an overtly negative light. This proposal is consistent with the findings of a number of studies addressing social perception in depressed participants (e.g. Bollenbach & Madigan, 1982; Hoehn-Hyde et al, 1982). Of particular relevance to the current study are the findings of Hollander and Hokanson (1988), who reported that depressed individuals perceived less genuineness in people they viewed on videotape than did non-depressed individuals. However, it should also be noted that the ability to correctly interpret the interactions involving lies was also strongly related to executive performance and depression severity, which suggests that the failure to correctly interpret these interactions may have related to the same or similar deficits that were implicated in the interpretation of sarcasm. These findings will be considered further in the next section in light of the different cognitive models.

8.5. Cognitive theories of MD and the profile of emotional processing

As outlined in the introduction (section 1.5, page 31) early cognitive theories of depression, such as Beck's schema theory (Beck et al, 1967) or Bower's semantic network theory (Bower, 1981), predicted that depression would be associated with negative biases across all cognitive domains. However, as reported earlier, the empirical evidence that has been amassed over the subsequent decades since their theories were proposed does not support this prediction. Williams, Watts, Macleod and Mathews (1997) proposed an alternative cognitive model of depression that can account for some of the discrepancies in the data that could not be explained in terms of the early cognitive theories. The central proposal of their theory is that depression affects the strategic elaboration phase of cognitive processing but exerts little or no

affect on pre-attentive processing. For example, according to this model, the robust MCM bias associated with major depression is a consequence of the patients strategically allocating processing resources to the elaboration of the depression-relevant material. This notion can be applied to the findings of two experimental studies included in this thesis (reported in chapters 3 & 5, pages 52 & 125 respectively) in order to account for the failure to demonstrate the predicted MCM bias for depression-relevant material. During the encoding phase of the study (reported in chapter 3, page 52) the to-be-remembered words were presented concurrently with to-be-ignored emotional faces. Inspection of the performance of the depressed patients during encoding revealed that they failed to inhibit the faces, suggesting that they were processing all elements of the stimulus. A consequence of the patients' unconstrained attentional style may have been a reduction in the amount of available cognitive resources that could have been allocated to elaborate the depression-relevant words, which would account for the lack of MCM bias in this study.

In the second of these studies (reported in chapter 5, page 125) the encoding task simply required the participants to identify the gender of a series of individuals featured in a set of photographs. The individuals featured in the photographs also portrayed emotional expressions, but no explicit reference was made to this fact (i.e. the participants were not explicitly requested to ignore the emotion portrayed in order to make their gender judgement). It is likely that gender identification is a largely automatic process and thus would not have required deep processing of the faces at encoding. In line with this notion, inspection of the encoding task data (page 137) revealed that both groups of participants were able to make the gender identifications

extremely quickly and moreover the emotional valence of the faces did not influence the participants' performance of this task. Thus in terms of the model proposed by Williams et al (1997) gender identification would not have required elaborative processing of the faces and hence a MCM memory bias would not be expected.

The finding that the gender identification times of the depressed individuals (reported in chapter 5, page 137) were not affected by the valence of the facial expressions is consistent with the Williams et al' model (1997). As the faces were only present on the screen for a relatively short duration a mood congruent bias in this circumstance would have suggested biased processing at the early pre-attentive (automatic) stage, which was not evident in the current study.

The finding from the study that utilised the face-word variant of the emotional Stroop task (reported in chapter 3, page 79) that depressed individuals did not selectively attend to sad faces is also consistent with the model proposed by Williams and colleagues. However, it is plausible that the positive face bias demonstrated by the controls (page, 79) represented biased attention at the early, automatic, processing stage. As proposed by Power and Dalglish (1997) the lack of such a positive bias in the depressed individuals could also be interpreted as a negative bias and would therefore suggest that there might be changes in pre-attentive processing associated with major depression. This notion is not consistent with the model proposed by Williams et al. (1988; 97). Furthermore, the finding (reported in chapter 3, page 84) that, relative to the healthy individuals, depressed individuals demonstrated a greater incidence of false recognition of non-presented, but highly-depression-related, words also suggests that major depression might be associated with changes in automatic

processing, as this finding is best accounted for as a consequence of emotional priming. This finding is also not consistent with the Williams' model (1988; 97). It is clear that the cognitive model proposed by Williams et al (1997) is able to account for the considerable amount of the available empirical evidence concerning the profile of emotional processing in major depression. In particular, this model represents a good starting point to investigate why certain types of cognitive bias may be more or less evident in the different emotional disorders. However, as noted above, there are a number of findings that are not easily accommodated within this model. These findings tend to be complex in nature and, as such, cannot be adequately explained in terms of the relatively simple frameworks outlined above. Therefore, in order to completely 'capture' the nature of major depression, particularly the complex interaction between the cognitive and emotional elements of this disorder a more complex cognitive model is required, such as the Interacting Cognitive Subsystems (ICS) model (Teasdale & Barnard, 1993).

According to the ICS model, depression is a consequence of the generation of depressogenic schematic models in the implicational subsystem and is maintained via a feedback loop with the propositional subsystem. In effect, the active schematic model generates propositions such as "I am useless" that feed back to the implicational subsystem reinforcing the active schematic model. The activation of depressogenic schematic models biases ongoing processing towards negative material and away from positive material. Therefore, it is clear that a number of the findings in the current studies fit this notion. For example, the lack of positive bias in the study reported in chapter three and the impaired identification of happiness reported in chapter six. Furthermore, the findings of greater accuracy of negative word

identification and the priming of depression-relevant words reported in chapter three are also consistent with this notion. It is plausible that the findings, from chapter four, that face cues significantly impaired depressed individuals' retrieval of specific memories relates to a greater propensity of these to activate representations of the affective elements of previous events. Finally, the failure to demonstrate MCM bias in chapter three and five can also be accounted for in terms of the ICS model, as it is unlikely that the encoding phases of these studies would have enabled, or encouraged, the representation of the affective elements of the experimental stimuli. These proposals are speculative and would require future investigation in order to elaborate them. The subsequent section will now consider the role of the executive processing in terms of the observed pattern of emotional processing

8.6. Executive function, emotional processing and major depression

As noted in the introduction to this thesis (section 1.2.4, page 9) there is considerable evidence to suggest that major depression is associated with marked deficits in executive function. A consistent theme that has emerged during the body of work reported in this thesis is that the executive processes appear to play an important role in emotional and social processing, as deficits in executive function that are associated with depression appear to be implicated in many of the changes in emotional processing exhibited by the depressed patients in the current studies. For instance, the finding that depressed individuals exhibited difficulty in inhibiting the distracting faces during the selective attention task of chapter three. This suggests that depression is associated with deficits in controlled attention and is consistent with previous findings (e.g. MacQueen et al, 1999) that have reported impaired performance on tasks that require inhibition of 'off-task' stimuli in order to respond to

the to-be-attended-to stimuli. In the recognition memory phase of the study reported in chapter three, relative to healthy controls, depressed individuals demonstrated impaired memory for the words that had been paired with the faces at encoding. Hertel (1997) proposed that the failure of depressed individuals to control the allocation of attention was central to the memory impairments exhibited by these participants, thus it is plausible that the observed memory deficit was a consequence of the patients impaired ability to inhibit the processing of the faces at encoding. It has been suggested in numerous studies (e.g. Conway et al, 2001) that the central executive may play an important role in the retrieval of specific ABMs. Furthermore, Williams (1996) argued that access to specific ABMs requires inhibition of intermediate descriptions in order for contextual information (e.g. time & place) to be added to the search, which he suggested involved executive processes. In the current ABM study depressed individuals were particularly impaired at producing specific ABMs to face cues. There is some evidence to suggest that this was a consequence, at least in part, of induced rumination in depressed patients. In line with this notion, previous studies (e.g. Watkins & Teasdale, 2001) have reported that rumination in depression was associated with greater overgeneral retrieval. Watkins and Brown (2002) reported that rumination in depression impaired executive processes involved thought to be involved in inhibition, which is consistent with the rumination explanation of the increase in categorical retrieval by the patients in the faces condition. Alternative/additional explanations of the increased retrieval of categorical memories by the depressed patients in the face condition of the study reported in chapter four include that the face cues may have required greater processing capacity than the other stimuli. It is plausible that the increased cognitive demand associated with the face cues depleted available resources. It is also plausible that the increase in

categorical retrieval was a consequence of the generic properties of the face cues. The generic nature of these cues may have encouraged activation of general memories that would have to have been inhibited in order to progress to a specific ABM, and as depression is associated with deficits in the executive processes that involve inhibition they would have experienced greater difficulty than the controls in inhibiting these intermediate memories. Evidence from chapter six revealed that depressed individuals demonstrated impaired recognition of happy expressions relative to the controls. Further analysis revealed that the percentage of happy expressions correctly identified by the participants was negatively correlated with the number of errors committed on the Stroop task, suggesting that the impaired identification of happiness in depression was related to deficits in their executive processing. This relationship was still significant when depression severity was controlled for. Similarly, the depressed patients were shown to exhibit a deficit in the interpretation of social interactions that involved implied meaning (especially interactions involving sarcasm but also interactions involving 'white lies'). Further investigation revealed that the percentage of sarcastic interactions (and white lies) correctly interpreted by the participants was negatively correlated with the number of Stroop errors and positively related to errors on the Hayling's, these data suggest that performance on the emotional processing tasks required executive processes. However, it should be noted that these relationships were markedly diminished when depression severity was controlled for, suggesting that depression severity accounted for the difference in both emotional processing and executive performance, perhaps by reducing the capacity of available processing resources. The findings of chapter seven also provide evidence implicating the executive processes in the processing of emotional material. This study reported that patients that had undergone a surgical intervention for chronic, treatment-

refractory depression exhibited a general deficit in emotion recognition from dynamic social displays. Further analysis revealed that the percentage of emotional displays correctly recognised was negatively correlated with the participants' performance on the Stroop task, which suggests that the deficit in emotion recognition was related to impaired executive processing. This relationship held even when depression severity was controlled for, suggesting that it may have been a consequence of the surgery. The next section of this chapter will consider the possible neural underpinnings of emotional processing in major depression.

8.7. Neural correlates of emotional processing in MD

As the studies reported in this thesis did not involve direct measurement (e.g. using brain imaging techniques) of the neural systems that were utilised by the participants to perform the different cognitive tasks, it will not be possible to make any strong claims concerning the neural basis of the reported findings. However, based on the participants' performance on the standard neuropsychological tests (with well documented neural underpinnings) utilised during the current studies and the findings of previous studies investigating the neural correlates of major depression and the associated cognitive impairment, it will be possible to make some plausible speculations. Furthermore, the findings of chapter seven demonstrating emotion recognition and social processing impairments in patients that have undergone circumscribed lesions to particular brain regions also provided neuropsychological evidence of the possible neural underpinnings of the processes involved in performing these tasks.

8.7.1. Anterior cingulate (AC) function and the profile of emotional processing in MD

As reported in chapter one (section 1.6, page 36) there is strong evidence to suggest that major depression is associated with reduced activity in the anterior cingulate (AC) cortex. Furthermore, there is empirical support for the proposal that the AC plays an important role in many executive processes (including conflict monitoring & resolution). With this in mind, it would seem plausible that the finding (reported in chapter 3, page 70) that depressed individuals were impaired in identifying the emotional valence of words that were presented with incongruent emotional faces relates to impaired AC function in these patients. Furthermore, evidence presented in chapters six and seven (pages 146 & 177 respectively) provides evidence in support of the proposal that depressed individuals' impaired interpretation of social interactions involving sarcasm may also have related to a disruption of AC function in these patients, as correct interpretation of these emotional displays was strongly related to performance on the executive tasks (Stroop and Hayling's). Further supportive evidence of the involvement of the AC in correct interpretation of sarcasm comes from the findings of the investigation outlined in chapter seven (page 177) demonstrating that surgical lesions to the AC were also associated with impaired interpretation of sarcasm. Importantly, the impairment of social perception demonstrated by the surgery patients (reported in chapter 7) was independent of the influence of depression severity.

Numerous studies have implicated the central executive in the retrieval of specific ABMs (see chapter 4, page 90) and, in line with this proposal Conway et al (2001) reported increased activation in the frontal lobes during ABM retrieval. However, it is also possible that the AC plays a role in the retrieval of specific ABMs. For example,

Williams (1996) suggested that successful retrieval of specific ABMs requires the inhibition of the intermediate categorical descriptions in order to allow contextual information (e.g. time and place etc) to be added to the memory search and it is plausible that the AC could be involved in this process of inhibition. In line with this notion there is evidence (see section 1.6, page 36) that the AC is involved in the control processes that are associated with memory function.

8.7.2. Orbitofrontal cortex (OFC) and emotional processing in MD

It has been suggested (e.g. Rolls, 1999) that the OFC is involved in the processing of emotional material. In line with this notion Hornak et al (2003) reported that lesions to this region were associated with impaired recognition of emotion from faces and vocalisations. Furthermore, it has been demonstrated (see section 1.6, page 36) that major depression is associated with reduced activity in this brain region. With this in mind, it would seem highly plausible that the observed impairment in the recognition of positive emotion, and happiness in particular (reported in chapter 6, page 163) could relate to the dysfunction of the OFC reported in these patients. However, as the percentage of happy expressions correctly recognised was related to executive performance it also possible that attentional control mediated by the AC was involved in this finding.

8.7.3. Summary and conclusions: Neural correlates of emotional processing in MD

From the above it would seem likely that disruption to the normal functioning of the AC and OFC in major depression contributed to a number of the changes in emotional processing that were observed in the depressed patients during the experiments making up this thesis. It is speculative, but plausible, that these deficits in cortical

function also contributed to the other changes in emotional processing observed during the current experiments. However, further research is required (e.g. using brain imaging techniques) in order to confirm the role of these regions in the performance of the tasks mentioned above, and also to establish if these regions are recruited during the performance of the other emotion processing tasks (e.g. memory for emotional material).

8.8. Implications of the current findings

8.8.1. Theoretical and methodological implications

From the introduction of this thesis it can be seen that there have been numerous studies addressing impairments in cognitive performance in major depression. Similarly, there has been a considerable amount of work concerning changes in emotional processing in these patients. However, it is clear that these two lines of enquiry have largely taken place in isolation from each other. With this in mind, one of the aims of the current body of work was to consider the pattern of emotional processing exhibited by depressed individuals in light of the general cognitive dysfunction that has been reported in the literature. There is clear evidence from the current studies that impairment in general cognitive function was implicated in the observed pattern of emotional processing exhibited by the depressed patients. This has implications for the interpretation of many previous studies findings. As previous studies addressing emotional processing in depression have rarely included concurrent assessment of cognitive performance it is possible that the changes/deficits reported in these studies could well relate to general cognitive impairments in the patients, for example deficits in executive processing. Furthermore, it is clear from the current studies that depressed individuals demonstrated greater impairments when the stimuli

in question require greater cognitive processing or when the task difficulty was high, which suggests that reduced cognitive capacity in the depressed group may be implicated in the observed differences. With these findings in mind it is important that future investigations of emotional processing in depression take account of the difficulty of the tasks utilised, the possibility that reduced cognitive resources in the patients might account for their results and also the possible role of the executive processes.

It has been suggested that slowed retrieval times in depressed patients for positive ABMs represents reduced access to specific event memories. This has been demonstrated to relate to increased hopelessness in depressed patients. However, although the depressed patients in the current study demonstrated slowed retrieval of specific positive than negative memories they actually retrieved a greater percentage of specific positive than negative memories, which brings the explanation outlined above into question. Furthermore, according to the ICS model conditions that lead to direct access to emotional representations should lead to stronger mood-congruent effects. Thus in the current ABM study, as it was assumed that faces and images would have been associated with greater access to emotional representations than would the verbal cues, it would have been expected that stronger mood-congruent effects would have been observed in the responses to these stimuli. However, this pattern was not observed, which suggests that the non-verbal cues did not lead to greater access to emotional representations. However, the failure to observe the predicted mood-congruent effect on percentage of specific positive and negative ABMs cannot be accounted for in terms differences in stimulus type, as there was no differences in the patterns observed for words, faces or images.

8.8.2. Implications for depressed individuals everyday functioning

It is clear that the pattern of emotional processing, demonstrated by the depressed patients during the experimental studies reported in this thesis, could have serious consequences for their everyday functioning, particularly in terms of their social interactions with significant others. Of particular note are the findings concerning poor recognition of happiness and impaired understanding of sarcasm, as these deficits could lead to misunderstandings with significant others. The finding that the MCM bias for sad faces requires direct processing of the valence of the face is an important finding, particularly as there was no evidence that, relative to the controls, the depressed individuals were more sensitive to the valence of the faces at encoding. However, as everyday social interactions tend to occur over several minutes rather than seconds or parts of seconds it would seem likely that depressed individuals would become aware of sad expressions, which could lead to the MCM bias and reinforce their negative view of the world. Furthermore, in day-to-day social interactions the emotional expressions of others may be more salient than was the case in the studies reported in the current work (e.g. chapter five, page 125).

8.8.3. Implications for duration of ongoing episode

A number of the findings reported in this thesis have implications in terms of the maintenance of the depressive episode. For example, the observation that depressed patients fail to selectively attend to positive elements of their environment has been implicated in their failure to repair their mood. The poor recognition of happiness would also have the effect of colouring their view of the social interactions they are involved in. Likewise, a misunderstanding of social interactions (e.g. of sarcasm) could lead to interpersonal tension with significant others, which could undermine

these important social bonds and, subsequently lead to a worsening of mood. The findings of the ABM study suggest that certain types of stimuli (i.e. sad faces) might be more likely to result in negative ruminative cycles, which could act to reinforce or worsen ongoing depressed mood.

8.8.4. Implications for possible therapeutic intervention

As reported above, a number of findings reported in this thesis have suggested that major depression appears to be associated with impairment of the executive processes involved in detecting and resolving cognitive conflict. Furthermore, it has been demonstrated (e.g. chapters six & seven) that this impairment might contribute to other important deficits that have been observed in depression (e.g. comprehension of social interactions), which potentially have serious consequences in terms of the duration and severity of the patient's ongoing depressive episode. It is plausible that the impairment of executive processing that has been implicated in a number of the changes in emotional processing observed in the current studies might relate to a reduction in the capacity of available cognitive resources as a consequence of ongoing rumination in the depressed patients. Previous studies (e.g. Watkins et al, 2000) have reported that prevention of rumination (e.g. using a distraction manipulation) results in a marked improvement in cognitive performance. Furthermore, current psychological therapies that reduce the tendency of patients to ruminate (e.g. 'Mindfulness' therapy) have also been shown to improve cognitive performance, including on tasks relating to social functioning (Williams et al., 2000). If the observed impairments of social perception are related to increased rumination in the patients then it is feasible that therapies such as 'mindfulness' would lead to

improvements in the patients' social functioning, which could have positive effects upon the patients ongoing depressive episode.

8.9. Limitations of the current investigations

There were a number of limitations to the studies reported within this thesis that require note. In general, although the clinical assessment depressed sample was conducted according to a recognised diagnostic system (ICD-10; WHO, 1993) there was no information concerning the co-morbid conditions that may have been present in the patient group. This is important, as changes in cognitive/ emotional processing have also been reported in other psychological conditions (e.g. PTSD). In terms of the studies included in the thesis the most important co-morbid condition was considered to be anxiety, therefore a measure of anxiety was included in every study and the influence of anxiety on task performance was controlled for statistically. Furthermore, the assessment of the control group prior to inclusion in the studies took no formal measure of past depression, which means that it is possible that some of the control group may have experienced depressive symptoms in the past.

8.10. Future directions

The findings that the MCM for sad faces was not observed in the current study could be explained in terms of lack of elaboration due to the shallow depth of processing or in terms of the failure to represent the affective properties of the faces. A future study could examine this by manipulating the level of processing but still direct processing away from emotional valence (e.g. estimate age of person in picture). It is possible that the greater processing of the faces required for this task would not require access to semantic representations of the faces but might allow the emotional valence to

come to the attention of the participants, which could be observed in terms of a valence effect on age estimations times.

During the ABM study, the findings of increased categorical memories in the depressed patients under the face condition compared to the image or words conditions could be accounted for in terms of induced rumination on the part of the patients or it could be that the emotive properties of the faces were leading to the patients abandon the memory search early in the cycle in order to avoid the possibility of accessing a negative specific ABM. This could be investigated by establishing if manipulation of rumination prior to the ABM study (using the rumination/distraction paradigm) increases or decreases the production of the categorical ABMs in the face condition.

As noted in the previous section, it is possible that the cognitive impairment underlying the observed deficit in the patients' interpretation of social interactions relates to a reduction in available cognitive resources due to rumination. This could be tested in future by manipulating rumination in patients (using the rumination/distraction manipulation) prior to the social inference task.

8.11. Summary of thesis and conclusions

The primary aim of this thesis was to extend the previous work concerning the profile of emotional processing that is associated with major depression; in particular the aim was establish the pattern of processing that is associated with non-verbal stimuli. There was considerable support from the studies reported in this thesis that MD is associated with a negative bias in the processing of emotional material. This is

evidenced either by privileged processing of depression-relevant material (e.g. more accurate identification of negative words and false recognition of negative words) or by deficits in the processing of positive stimuli (e.g. impaired recognition of happiness, lack of positive attention bias to happy faces). These findings are consistent with the pattern of emotion processing reported in the literature for depressed individuals and suggest that the processing biases associated with words generalise to the processing of important non-verbal cues (e.g. faces & images). However, there were some notable differences between the verbal and non-verbal stimuli. For example, the finding from chapter four that controls retrieved more specific ABMs to images than to words. A further difference between the verbal and non-verbal stimuli was also observed in the ABM study, that was the finding that face cues produced even greater impairment of ABM specificity in the depressed group than was observed for words or images, this finding was unexpected, and possibly related to induced rumination in the patients or increased cognitive demand of the faces, which disproportionately affected the patients due to their reduced cognitive capacity. Another unexpected finding from this study was the finding that depressed individuals retrieved fewer specific negative than positive ABMs, a direct reverse of the normal pattern of data. This finding brings into question the normal interpretation of depressed individuals slowed retrieval times for positive ABMs. Other studies from the thesis also produced some unexpected findings, e.g. the failure to replicate the findings of Stenberg et al (1998) for the healthy participants on the face-word variant task was also unexpected, findings which might reflect differences in participant samples used in the two studies. An important theme that emerged throughout the thesis was that there appears to be an important role for the central executive in the processing of emotional material. Furthermore, many of the impairments in emotional

processing exhibited by the depressed patients appear to relate to the deficits in executive function. For example, the finding that depressed individuals exhibited marked impairment in their ability to inhibit their responses to the distracting faces on the face-word variant of the Stroop task. It was considered plausible that such executive deficits may account for many of the previous findings in the literature. However, as depression severity was also related to many of these findings it is also possible that both emotion processing deficits and impaired executive performance are a consequence of reduced processing capacity in the depressed sample. With this in mind, it is important that future studies addressing emotional processing in major depression take account of processing demands of the tasks they use, as well as depression severity and executive function of the participant sample. There is some evidence from the studies reported in the thesis that the executive dysfunction reported above relates to changes in the function of the anterior cingulate region of the prefrontal cortex. Evidence of the involvement of this region comes from the studies demonstrating strong relationships between emotion processing and performance on tasks (e.g. Stroop task), which are known to depend on normal AC function. It is clear that many of these findings have implications for depressed individuals' everyday functioning, particularly in terms of social interaction with significant others. Furthermore, the negative bias (or lack of positive bias) reported in many of the current studies could act to maintain or even worsen the ongoing depressive episode.

REFERENCES

- Abas, M. A., Sahakian, B. J., & Levy, R. (1990). Neuropsychological deficits and CT scan changes in elderly depressives. *Psychol Med*, 20(3), 507-520.
- Ambady, N., & Gray, H. M. (2002). On being sad and mistaken: mood effects on the accuracy of thin-slice judgments. *J Pers Soc Psychol*, 83(4), 947-961.
- Austin, M. P., Mitchell, P., Wilhelm, K., Parker, G., Hickie, I., Brodaty, H., et al. (1999). Cognitive function in depression: a distinct pattern of frontal impairment in melancholia? *Psychol Med*, 29(1), 73-85.
- Baddeley, A. D., & Hitch, G. (1974). Working memory. In G. H. Bower (Ed.), *The psychology of learning and motivation* (Vol. 8). London: Academic Press.
- Baddeley, A. D., & Wilson, B. (1986). Amnesia, autobiographical memory, and confabulation. In D. Rubin (Ed.), *Autobiographical memory* (pp. 225-252). Cambridge: Cambridge University Press.
- Banos, R. M., Medina, P. M., & Pascual, J. (2001). Explicit and implicit memory biases in depression and panic disorder. *Behav Res Ther*, 39, 61-74.
- Barry, E. S., Naus, M. J., & Rehm, L. P. (2004). Depression and implicit memory: Understanding mood-congruent memory bias. *Cognitive Therapy and Research*, 28(3), 387-414.
- Bazin, N., Perruchet, P., De Bonis, M., & Feline, A. (1994). The dissociation of explicit and implicit memory in depressed patients. *Psychol Med*, 24(1), 239-245.
- Beats, B. C., Sahakian, B. J., & Levy, R. (1996). Cognitive performance in tests sensitive to frontal lobe dysfunction in the elderly depressed. *Psychol Med*, 26(3), 591-603.

- Beck, A. T. (1967). *Depression: clinical, experimental, and theoretical aspects*. New York: Harper and Row.
- Beck, A. T., Rial, W. Y., & Rickels, K. (1974). Short form of depression inventory: cross-validation. *Psychol Rep*, 34(3), 1184-1186.
- Beck, A. T., Steer, R. A., & Garbin, M. G. (1988). Psychometric properties of the beck depression inventory: twenty-five years of evaluation. *Clinical Psychology Review*, 8, 77-100.
- Beck, A. T., Ward, C. H., Mendelson, C. H., Mock, J., & Erbaugh, J. (1961). An inventory for measuring depression. *Archives of General Psychiatry*, 4, 561 - 571.
- Bench, C. J., Friston, K. J., Brown, R. G., Scott, L. C., Frackowiak, R. S., & Dolan, R. J. (1992). The anatomy of melancholia - focal abnormalities of cerebral blood flow in major depression. *Psychological Medicine*, 22, 607-615.
- Binder, D. K., & Iskandar, B. J. (2000). Modern neurosurgery for psychiatric disorders. *Neurosurgery*, 47(1), 9-21; discussion 21-23.
- Blaney, P. H. (1986). Affect and memory: a review. *Psychol Bull*, 99(2), 229-246.
- Blazer, D. G., Kessler, R. C., McGonagle, K. A., & Swartz, M. S. (1994). The prevalence and distribution of major depression in a national community sample. The national comorbidity survey. *American Journal of Psychiatry*, 151, 979-986.
- Bollenbach, A. K., & Madigan, R. J. (1982). Effects of induced mood on social cognitions. *Psychological Reports*, 513(763 - 769).
- Bouhuys, A. L., Bloem, G. M., & Groothuis, T. G. (1995). Induction of depressed and elated mood by music influences the perception of facial emotional expressions in healthy subjects. *J Affect Disord*, 33(4), 215-226.

- Bower, G. H. (1981). Mood and memory. *American Psychologist*, 36, 129 - 148.
- Bradley, B. P., & Mathews, A. (1983). Negative self-schemata in clinical depression. *British Journal of Clinical Psychology*, 22, 173-181.
- Bradley, B. P., Mogg, K., Falla, S. J., & Hamilton, L. R. (1998). Attentional Bias for threatening facial expressions in anxiety: Manipulation of stimulus duration. *Cognition and Emotion*, 12(6), 737-753.
- Bradley, B. P., Mogg, K., & Lee, S. (1997a). Attentional biases for negative information in induced and naturally occurring dysphoria. *Behaviour Research and Therapy*, 35(10), 911-927.
- Bradley, B. P., Mogg, K., Millar, N., Bonham-Carter, C., Fergusson, E., Jenkins, J., et al. (1997b). Attentional biases for emotional faces. *Cognition and Emotion*, 11(1), 25-42.
- Bradley, B. P., Mogg, K., & Williams, R. (1995). Implicit and explicit memory for emotion-congruent information in clinical depression and anxiety. *Behav Res Ther*, 33(7), 755-770.
- Brittlebank, A. D., Scott, J., Williams, J. M., & Ferrier, I. N. (1993). Autobiographical memory in depression: state or trait marker? *Br J Psychiatry*, 162, 118-121.
- Broadbent, D. E., Broadbent, M. H., & Jones, J. L. (1986). Performance correlates of self-reported cognitive failure and obsessionality. *Br J Clin Psychol*, 25, 285-299.
- Brown, R. G., Scott, L. C., Bench, C. J., & Dolan, R. J. (1994). Cognitive function in depression: its relationship to the presence and severity of intellectual decline. *Psychol Med*, 24(4), 829-847.
- Burke, M., & Mathews, A. (1992). Autobiographical memory and clinical anxiety. *Cognition and Emotion*, 6, 23-35.

- Butler, G., & Mathews, A. (1983). Cognitive processes in anxiety. *Advances in Behaviour Research and Therapy*, 5, 51-62.
- Calarge, C., Andreasen, N. C., & O'Leary, D. S. (2003). Visualizing how one brain understands another: a PET study of theory of mind. *Am J Psychiatry*, 160(11), 1954-1964.
- Channon, S. (1996). Executive dysfunction in depression: the Wisconsin Card Sorting Test. *J Affect Disord*, 39(2), 107-114.
- Channon, S., & Green, P. S. (1999). Executive function in depression: the role of performance strategies in aiding depressed and non-depressed participants. *J Neurol Neurosurg Psychiatry*, 66(2), 162-171.
- Christensen, H., Griffiths, K., Mackinnon, A., & Jacomb, P. (1997). A quantitative review of cognitive deficits in depression and Alzheimer- type dementia. *J Int Neuropsychol Soc*, 3(6), 631-651.
- Clark, D. M., & Teasdale, J. D. (1982). Diurnal variation in clinical depression and accessibility of memories of positive and negative experiences. *J Abnorm Psychol*, 91(2), 87-95.
- Cohen, J. (1992). A power primer. *Psychological Bulletin*, 112(1), 155 -159.
- Cohen, R. A., Kaplan, R. F., Moser, D. J., Jenkins, M. A., & Wilkinson, H. (1999). Impairments of attention after cingulotomy. *Neurology*, 53, 819-824.
- Conway, M. A., Pleydell - Pearce, C., & Whitecross, S. E. (2001). The neuroanatomy of autobiographical memory: A slow cortical potential study of autobiographical retrieval. *Journal of memory and language*, 45, 493 - 524.
- Conway, M. A., & Rubin, D. C. (1993). The structure of autobiographical memory. In A. E. Collins, S. E. Gathercole, M. A. Conway & P. E. Morris (Eds.), *Theories of memory* (pp. 103-138). Hove: Sussex: Lawrence Elrbaum Associates.

- Cooley, E. L., & Nowicki, S., Jr. (1989). Discrimination of facial expressions of emotion by depressed subjects. *Genet Soc Gen Psychol Monogr*, 115(4), 449-465.
- Crawford, J. R., Besson, J. A. O., Parker, D. M., Sutherland, K. M., & Keen, P. L. (1987). Estimation of premorbid intellectual status in depression. *British Journal of Clinical Psychology*, 26, 313 - 314.
- Dalgleish, T., & Watts, F. N. (1990). Biases of attention and memory in disorders of anxiety and depression. *Clinical Psychology Review*, 10, 589-604.
- Degl'Innocenti, A., & Backman, A. H. (1998). Executive deficits in major depression. *Acta Psychiatrica Scandinavica*, 97, 182 - 188.
- Deijen, J. B., Orlebeke, J. F., & Rijdsdijk, F. V. (1993). Effect of depression on psychomotor skills, eye movements and recognition-memory. *J Affect Disord*, 29(1), 33-40.
- Denny, E. B., & Hunt, R. R. (1992). Affective valence and memory in depression: dissociation of recall and fragment completion. *J Abnorm Psychol*, 101(3), 575-580.
- Derry, P. A., & Kuiper, N. A. (1981). Schematic processing and self-reference in clinical depression. *Journal of Abnormal Psychology*, 90, 286-297.
- Dewhurst, S. A., & Conway, M. A. (1994). Pictures, images, and recollective experience. *J Exp Psychol Learn Mem Cogn*, 20(5), 1088-1098.
- Drevets, W. C., & Raichle, M. E. (1992). Neuroanatomical circuits in depression: implications for treatment mechanisms. *Psychopharmacol Bull*, 28(3), 261-274.

- Drevets, W. C., Videen, T. O., Price, J. L., Preskorn, S. H., Carmichael, S. T., & Raichle, M. E. (1992). A functional anatomical study of unipolar depression. *J Neurosci*, 12(9), 3628-3641.
- Drevets, W. C., Price, J. L., Simpson, J. R., Todd, R. D., Reich, T., Vannier, M., et al. (1997). Subgenual prefrontal cortex abnormalities in mood disorders. *Nature*, 386(6627), 824-827.
- Dunbar, G. C., & Lishman, W. A. (1984). Depression, recognition-memory and hedonic tone a signal detection analysis. *Br J Psychiatry*, 144, 376-382.
- Elliott, R. (1998). The neuropsychological profile in unipolar depression. *Trends in Cognitive Sciences*, 2(11), 447-454.
- Elliott, R., Baker, S. C., Rogers, R. D., O'Leary, D. A., Paykel, E. S., Frith, C. D., et al. (1997). Prefrontal dysfunction in depressed patients performing a complex planning task: a study using positron emission tomography. *Psychol Med*, 27(4), 931-942.
- Elliott, R., & Dolan, R. J. (1998). The neural response in short-term visual recognition memory for perceptual conjunctions. *Neuroimage*, 7(1), 14-22.
- Elliott, R., Sahakian, B. J., Herrod, J. J., Robbins, T. W., & Paykel, E. S. (1997). Abnormal response to negative feedback in unipolar depression: evidence for a diagnosis specific impairment. *J Neurol Neurosurg Psychiatry*, 63(1), 74-82.
- Elliott, R., Sahakian, B. J., McKay, A. P., Herrod, J. J., Robbins, T. W., & Paykel, E. S. (1996). Neuropsychological impairments in unipolar depression: the influence of perceived failure on subsequent performance. *Psychol Med*, 26(5), 975-989.

- Elliott, R., Sahakian, B. J., Michael, A., Paykel, E. S., & Dolan, R. J. (1998). Abnormal neural response to feedback on planning and guessing tasks in patients with unipolar depression. *Psychol Med*, 28(3), 559-571.
- Ellis, H. C., & Ashbrook, P. W. (1988). Resource allocation model of the effects of depressed mood states on memory. In K. Fiedler & J. Forgas (Eds.), *Affect, cognition, and social behaviour*. Toronto, Canada: Hogrefe.
- Evans, J., Williams, J. M., O'Loughlin, S., & Howells, K. (1992). Autobiographical memory and problem-solving strategies of parasuicide patients. *Psychol Med*, 22(2), 399-405.
- Eysenck, M. W., & Keane, M. T. (1995). *Cognitive psychology: A students handbook* (3rd ed.). Hove, UK: Psychology Press.
- Feinberg, T. E., Rifkin, A., Schaffer, C., & Walker, E. (1986). Facial discrimination and emotional recognition in schizophrenia and affective disorders. *Arch Gen Psychiatry*, 43(3), 276-279.
- Fletcher, P. C., Frith, C. D., Grasby, P. M., Shallice, T., Frackowiak, R. S., & Dolan, R. J. (1995). Brain systems for encoding and retrieval of auditory-verbal memory. An in vivo study in humans. *Brain*, 118(Pt 2), 401-416.
- Fox, E., Russo, R., & Dutton, K. (2002). Attentional bias for threat: Evidence for delayed disengagement from emotional faces. *Cognition and Emotion*, 16(3), 355 - 379.
- Francis, W. N., & Kucera, H. (1982). *Frequency analysis of English usage. Lexicon and grammar*. Boston, Mass: Houghton and Mifflin.
- Friedman, A. S. (1964). Minimal Effects of Severe Depression on Cognitive Functioning. *J Abnorm Psychol*, 69, 237-243.

- Gallagher, H. L., Happe, F., Brunswick, N., Fletcher, P. C., Frith, U., & Frith, C. D. (2000). Reading the mind in cartoons and stories: an fMRI study of "theory of mind" in verbal and nonverbal tasks. *Neuropsychologia*, 38, 157-166.
- Gallagher, R. (2000). Case presentation: demise by decision, dementia, or depression? *J Pain Symptom Manage*, 20(3), 233-234.
- Gardiner, J. M., & Java, R. I. (1993). Recognising and remembering. In A. F. Collins, S. E. Gathercole, M. A. Conway & P. E. Morris (Eds.), *Theories of Memory*. Hove, UK: Lawrence Erlbaum Associates Ltd.
- George, M. S., Ketter, T. A., Parekh, P. I., Rosinsky, N., Ring, H. A., Pazzaglia, P. J., et al. (1997). Blunted left cingulate activation in mood disorder subjects during a response interference task (the Stroop). *J Neuropsychiatry Clin Neurosci*, 9(1), 55-63.
- Goddard, L., Dritschel, B., & Burton, A. (1996). Role of autobiographical memory in social problem solving and depression. *J Abnorm Psychol*, 105(4), 609-616.
- Golinkoff, M., & Sweeney, J. A. (1989). Cognitive impairments in depression. *J Affect Disord*, 17(2), 105-112.
- Goodwin, G. M., Austin, M. P., Dougall, N., Ross, M., Murray, C., O'Carroll, R. E., et al. (1993). State changes in brain activity shown by the uptake of ^{99m}Tc-exametazime with single photon emission tomography in major depression before and after treatment. *J Affect Disord*, 29(4), 243-253.
- Gotlib, I. H., & Cane, D. B. (1987). Construct accessibility and clinical depression: a longitudinal investigation. *Journal of Abnormal Psychology*, 96, 199 - 204.
- Gotlib, I. H., Krasnoperova, E., Yue, D. N., & Joormann, J. (2004). Attentional biases for negative interpersonal stimuli in clinical depression. *J Abnorm Psychol*, 113(1), 121-135.

- Gotlib, I. H., McLachlan, A. L., & Katz, A. N. (1988). Biases in visual attention in depressed and nondepressed individuals. *Cognition and Emotion*, 2(3), 185-200.
- Graf, P., & Mandler, G. (1984). Activation makes words more accessible, but not necessarily more retrievable. *Journal of Verbal Learning and Verbal Behavior*, 23, 553-568.
- Green, S. B., & Salkind, N. J. (2003). *Using SPSS for Windows and Macintosh: analyzing and understanding data* (3rd ed.). New Jersey: Prentice Hall.
- Hamilton, M. (1960). A rating scale for depression. *Journal of Neurology, Neurosurgery and Psychiatry*, 23, 56-62.
- Hammen, C. (1997). *Depression*. Hove, UK: Psychology Press, Taylor and Francis Group.
- Happe, F., Malhi, G. S., & Checkley, S. (2001). Acquired mind-blindness following frontal lobe surgery? A single case study of impaired 'theory of mind' in a patient treated with stereotactic anterior capsulotomy. *Neuropsychologia*, 39(1), 83-90.
- Hartlage, S., Alloy, L. B., Vazquez, C., & Dykman, B. (1993). Automatic and effortful processing in depression. *Psychol Bull*, 113(2), 247-278.
- Hasher, L., & Zacks, R. T. (1979). Automatic and effortful processes in memory. *Journal of Experimental Psychology: General*, 114, 104 -118.
- Heaton, R. K. (1981). Wisconsin Card Sorting Task (WCST). Odessa, Florida: Psychological Assessment Resources.
- Hedlund, J., & Vieweg, B. (1979). The Hamilton Rating Scale for Depression: A comprehensive review. *Journal of Operational Psychiatry*, 10, 149-162.

- Hertel, P. T. (1997). On the contributions of deficient cognitive control to memory impairments in depression. *Cognition and Emotion*, 11(5/6), 569-583.
- Hertel, P. T., & Rude, S. S. (1991). Depressive deficits in memory: Focusing attention improves subsequent recall. *Journal of Experimental Psychology: General*, 120, 301 - 309.
- Hill, A. B., & Knowles, T. H. (1991). Depression and the emotional Stroop effect. *Personality and Individual Differences*, 12, 481-485.
- Hoehn-Hyde, D., Schlottmann, R. S., & Rush, A. J. (1982). Perception of social interactions in psychiatric patients. *Journal of Psychopathology and Behavioural Assessment*, 14(1), 1 - 19.
- Hollander, G. R., & Hokanson, J. E. (1988). Dysphoria and the perception of incongruent communications. *Cognitive Therapy and Research*, 12(6), 577 - 589.
- Hornak, J., Bramham, J., Rolls, E. T., Morris, R. G., O'Doherty, J., Bullock, P. R., et al. (2003). Changes in emotion after circumscribed surgical lesions of the orbitofrontal and cingulate cortices. *Brain*, 126(Pt 7), 1691-1712.
- Hornak, J., Rolls, E. T., & Wade, D. (1996). Face and voice expression identification in patients with emotional and behavioural changes following ventral frontal lobe damage. *Neuropsychologia*, 34(4), 247-261.
- Ilisley, J. E., Moffoot, A. P., & O' Carroll, R. E. (1995). An analysis of memory dysfunction in major depression. *Journal of Affective Disorders*, 35, 1-9.
- Ingram, R. E., & Wisnicki, K. (1991). Cognition in depression. In P. A. Magaro (Ed.), *Annual Review of Psychopathology* (Vol. 1, pp. 187 - 230). Newbury Park, California: Sage.

- Johnson, M. H., & Magaro, P. A. (1987). Effects of mood and severity on memory processes in depression and mania. *Psychol Bull*, 101(1), 28-40.
- Katz, R., Shaw, B. F., Vallis, T. M., & Kaiser, A. S. (1995). The Assessment of Severity and Symptom Patterns in Depression. In E. Beckham & W. R. Leber (Eds.), *Handbook of Depression* (Second ed., pp. 61 - 85). London: The Guilford Press.
- Krantz, S., & Hammen, C. (1979). Assessment of cognitive bias in depression. *J Abnorm Psychol*, 88(6), 611-619.
- Kuyken, W., & Brewin, C. R. (1995). Autobiographical memory functioning in depression and reports of early abuse. *J Abnorm Psychol*, 104(4), 585-591.
- Lamelin, S., Baruch, P., Vincent, A., Everett, J., & Vincent, P. (1997). Distractibility and processing resource deficit in major depression. Evidence for two deficient attentional models. *Journal of Nervous and Mental Disease*, 185(9), 542 - 548.
- Lang, P. J., Greenwald, M. K., Bradley, M. M., & Hamm, A. O. (1993). Looking at pictures: Affective, facial, visceral, and behavioral reactions. *Psychophysiology*, 30, 261-273.
- Lang, P. J., Bradley, M. M., & Cuthbert, B. N. (1997). *The International Affective Picture System: user manual and subjective ratings*. Gainesville: University of Florida.
- Le Gal, T., & Bruce, V. (1999). *Cognitive aspects of emotional expression processing*. University of Stirling, Stirling.
- Lloyd, G. G., & Lishman, W. A. (1975). Effect of depression on the speed of recall of pleasant and unpleasant experiences. *Psychol Med*, 5(2), 173-180.

- Loeb, A., Beck, A. T., Feshbach, S., & Wolf, A. (1964). Some Effects of Regard Upon the Social Perception and Motivation of Psychiatric Patients Varying in Depression. *J Abnorm Psychol*, 68, 609-616.
- Lundqvist, L. O., & Dimberg, U. (1995). Facial emotions are contagious. *Journal of Psychophysiology*, 9(3), 203-211.
- Lyubomirsky, S., Caldwell, N. D., & Nolen - Hoeksema, S. (1998). Effects of ruminative and distracting responses to depressed mood on retrieval of autobiographical memories. *Journal of Personality and Social Psychology*, 75(1), 166 - 177.
- MacLeod, C., Mathews, A., & Tata, P. (1986). Attentional bias in emotional disorders. *J Abnorm Psychol*, 95(1), 15-20.
- MacLeod, C. M. (1991). Half a century of research on the Stroop effect: an integrative review. *Psychol Bull*, 109(2), 163-203.
- MacQueen, G. M., Tipper, S. P., Young, L. T., Joffe, R. T., & Levitt, A. J. (2000). Impaired distractor inhibition on a selective attention task in unmedicated, depressed subjects. *Psychol Med*, 30(3), 557-564.
- Mandal, M. K., & Bhattacharya, B. B. (1985). Recognition of facial affect in depression. *Percept Mot Skills*, 61(1), 13-14.
- Mathews, A., May, J., Mogg, K., & Eysenck, M. W. (1990). Attentional bias in anxiety: selective search or defective filtering? *Journal of Abnormal Psychology*, 99, 166-173.
- Matt, G. E., Vazquez, C., & Campbell, W. K. (1992). Mood-congruent recall of affectively toned stimuli: A meta-analytic review. *Clinical Psychology Review*, 12, 227-255.

- Matthews, K., & Eljamel, M. S. (2003). Status of neurosurgery for mental disorder in Scotland. Selective literature review and overview of current clinical activity. *Br J Psychiatry*, 182, 404-411.
- McAllister, T. W. (1981). Cognitive functioning in the affective disorders. *Compr Psychiatry*, 22(6), 572-586.
- McDonald, S., Flanagan, S., & Rollins, J. (2002). The Awareness of Social Inference Test. Bury St Edmonds, England: Thames Valley Test Company Limited.
- McDonald, S., Flanagan, S., Rollins, J., & Kinch, J. (2003). TASIT: A new clinical tool for assessing social perception after traumatic brain injury. *J Head Trauma Rehabil*, 18(3), 219-238.
- McFall, R. M. (1982). A review and formulation of the concept of social skills. *Behaviour Assessment*, 4, 1-33.
- McNally, R. J., Lasko, N. B., Macklin, M. L., & Pitman, R. K. (1995). Autobiographical memory disturbance in combat-related posttraumatic stress disorder. *Behav Res Ther*, 33(6), 619-630.
- McNally, R. J., Litz, B. T., Prassas, A., Shin, L. M., & Weathers, F. W. (1994). Emotional priming of autobiographical memory in post-traumatic stress disorder. *Cognition and Emotion*, 8(4), 351-367.
- Mialet, J. P., Pope, H. G., & Yurgelun-Todd, D. (1996). Impaired attention in depressive states: a non-specific deficit? *Psychol Med*, 26(5), 1009-1020.
- Miller, W. R. (1975). Psychological deficits in depression. *Psychol Bull*, 82, 238-260.
- Mindus, P., Edman, G., & Andreewitch, S. (1999). A prospective, long-term study of personality traits in patients with intractable obsessional illness treated by capsulotomy. *Acta Psychiatr Scand*, 99(1), 40-50.

- Mineka, S., Watson, D., & Clark, L. A. (1998). Comorbidity of anxiety and unipolar mood disorders. *Annu Rev Psychol*, 49, 377-412.
- Moffoot, A. P., O'Carroll, R. E., Bennie, J., Carroll, S., Dick, H., Ebmeier, K. P., et al. (1994). Diurnal variation of mood and neuropsychological function in major depression with melancholia. *J Affect Disord*, 32(4), 257-269.
- Montgomery, S. A., & Asberg, M. (1979). A new depression scale designed to be sensitive to change. *Br J Psychiatry*, 134, 382-389.
- Moore, R. G., Watts, F. N., & Williams, J. M. (1988). The specificity of personal memories in depression. *Br J Clin Psychol*, 27(Pt 3), 275-276.
- Morris, R. G., Evenden, J. L., Sahakian, B. J., & Robbins, T. W. (1987). Computer-aided assessment of dementia: comparative studies of neuropsychological deficits in Alzheimer-type dementia and Parkinson's disease. In S. M. Stahl, S. D. Iversen & E. G. Goodman (Eds.), *Cognitive Neurochemistry*. Oxford: Oxford University Press.
- Murphy, F. C., Sahakian, B. J., & O'Carroll, R. E. (1998). Cognitive impairment in depression: Psychological models and clinical issues. *Advanced Biological Psychiatry*, 19, 1 - 33.
- Murphy, F. C., Sahakian, B. J., Rubinsztein, J. S., Michael, A., Rogers, R. D., Robbins, T. W., et al. (1999). Emotional bias and inhibitory control processes in mania and depression. *Psychol Med*, 29(6), 1307-1321.
- Murray, C. J., & Lopez, A. D. (1996). Evidence-based health policy--lessons from the Global Burden of Disease Study. *Science*, 274(5288), 740-743.
- Murray, L. K., & Perret, D. (2000). *Facial expression perception in different psychiatric groups*. Unpublished Ph.D., University of St Andrews, St Andrews, Scotland, UK.

- Nelson, H. E., & Williamson, J. (1991). *National Adult Reading Test (NART) Test Manual* (second ed.). Windsor: NFER - NELSON.
- Nolen-Hoeksema, N. S. (1991). Responses to depression and their effects on the duration of depressive episodes. *Journal of Abnormal Psychology, 100*, 569-582.
- Norman, D. A., & Shallice, T. (1986). Attention to action: willed and automatic control of behaviour. In R. J. Davidson, G. E. Schwartz & D. Shapiro (Eds.), *Consciousness and self-regulation* (Vol. 4). New York: Plenum.
- Nunn, J. D., Mathews, A., & Trower, P. (1997). Selective processing of concern-related information in depression. *Br J Clin Psychol, 36*(Pt 4), 489-503.
- O' Hara, M., & Rehm, L. (1983). Hamilton Rating Scale for Depression: Reliability and validity of judgements of novice raters. *Journal of Consulting and Clinical Psychology, 48*, 318-319.
- O'Carroll, R. E., Conway, S., Ryman, A., & Prentice, N. (1997). Performance on the delayed word recall test (DWR) fails to differentiate clearly between depression and Alzheimer's disease in the elderly. *Psychol Med, 27*(4), 967-971.
- Palmer, B. W., Boone, K. B., Lesser, I. M., Wohl, M. A., Berman, N., & Miller, B. L. (1996). Neuropsychological deficits among older depressed patients with predominantly psychological or vegetative symptoms. *J Affect Disord, 41*(1), 17-24.
- Pardo, J. V., Pardo, P. J., Janer, K. W., & Raichle, M. E. (1990). The anterior cingulate cortex mediates processing selection in the Stroop attentional conflict paradigm. *Proc Natl Acad Sci U S A, 87*(1), 256-259.

- Park, R. J., Goodyer, I. M., & Teasdale, J. D. (2002). Categorical overgeneral autobiographical memory in adolescents with major depressive disorder. *Psychol Med*, 32(2), 267-276.
- Persad, S. M., & Polivy, J. (1993). Differences between depressed and nondepressed individuals in the recognition of and response to facial emotional cues. *J Abnorm Psychol*, 102(3), 358-368.
- Porterfield, T., Cook, M., Deary, I. J., & Ebmeier, K. P. (1997). Neuropsychological function and diurnal variation in depression. *J Clin Exp Neuropsychol*, 19(6), 906-913.
- Power, M. J., Cameron, C. M., & Dalgleish, T. (1996). Emotional priming in clinically depressed subjects. *J Affect Disord*, 38(1), 1-11.
- Power, M. J., & Dalgleish, T. (1997). *Cognition and Emotion: from order to disorder* (1st ed.). Hove: Taylor and Francis.
- Puffet, A., Jehin-Marchot, D., Timsit-Berthier, M., & Timsit, M. (1991). Autobiographic memory and major depressive states. *European Psychiatry*, 6, 141-145.
- Purcell, R., Maruff, P., Kyrios, M., & Pantelis, C. (1997). Neuropsychological function in young patients with unipolar major depression. *Psychol Med*, 27(6), 1277-1285.
- Rapee, R. M., McCallum, S. L., Melville, L. F., Ravenscroft, H., & Rodney, J. M. (1994). Memory bias in social phobia. *Behav Res Ther*, 32(1), 89-99.
- Richards, A., & Whittaker, T. M. (1990). Effects of anxiety and mood manipulation in autobiographical memory. *Br J Clin Psychol*, 29(Pt 2), 145-153.

- Richards, P. M., & Ruff, R. M. (1989). Motivational effects on neuropsychological functioning: comparison of depressed versus nondepressed individuals. *J Consult Clin Psychol*, 57(3), 396-402.
- Ridout, N., Astell, A. J., Reid, I. C., Glen, T., & O'Carroll, R. E. (2003). Memory bias for emotional facial expressions in major depression. *Cognition and Emotion*, 17(1), 101 - 122.
- Roediger, H. L., 3rd, & Blaxton, T. A. (1987). Effects of varying modality, surface features, and retention interval on priming in word-fragment completion. *Mem Cognit*, 15(5), 379-388.
- Roediger, H. L., & McDermott, K. B. (1995). Creatinng false memories: Remembering words not presented in lists. *journal of Experimental Psychology: Learning, memory and cognition*, 21(4), 803 - 814.
- Rolls, E. T. (1999). *The brain and emotion*. Oxford: Oxford University Press.
- Roy-Byrne, P. J., Weingartener, H., Bierer, L. M., Thompson, K., & Post, R. M. (1986). Effortful and automatic cognitive processes in depression. *Archives of General Psychiatry*, 43, 265-267.
- Ruizcaballero, J. A., & Gonzalez, P. (1994). Implicit memory bias in depressed and nondepressed subjects. *Cognition and Emotion*, 8(6), 555-569.
- Schmand, B., Kuipers, T., Van der Gaag, M., Bosveld, J., Bulthuis, F., & Jellema, M. (1994). Cognitive disorders and negative symptoms as correlates of motivational deficits in psychotic patients. *Psychol Med*, 24(4), 869-884.
- Segal, Z. V., Gemar, M., Truchon, C., Guirguis, M., & Horowitz, L. M. (1995). A priming methodology for studying self-representation in major depressive disorder. *J Abnorm Psychol*, 104(1), 205-213.

- Segal, Z. V., & Vella, D. D. (1990). Self-schema in major depression; replication and extension of a priming methodology. *Cognitive Research and Therapy*, 14, 161 - 176.
- Shah, P. J., O'Carroll, R. E., Rogers, A., Moffoot, A. P., & Ebmeier, K. P. (1999). Abnormal response to negative feedback in depression. *Psychol Med*, 29(1), 63-72.
- Smith, A. L., & Weissman, M. M. (1992). Epidemiology. In E. S. Paykel (Ed.), *Handbook of Affective Disorders* (pp. 111 -129). New York: Guilford.
- Stenberg, G., Wiking, S., & Dahl, M. (1998). Judging words at face value: Interference in a word processing task reveals automatic processing of affective facial expressions. *Cognition and Emotion*, 12(6), 755-782.
- Suslow, T., Junghanns, K., & Arolt, V. (2001). Detection of facial expressions of emotions in depression. *Perceptual and Motor Skills*, 92(3), 857 - 868.
- Swales, M. A., & Williams, j. M. G. (2001). Specificity of autobiographical memory and mood disturbance in adolescents. *Cognition and Emotion*, 15(3), 321 - 331.
- Swets, J. A., Tanner, W. C., & Birdsall, T. G. (1961). Decision processes in perception. *Psychological Review*, 68, 301-340.
- Swick, D., & Jovanovic, J. (2002). Anterior cingulate cortex and the Stroop task: neuropsychological evidence for topographic specificity. *Neuropsychologia*, 40(8), 1240-1253.
- Tarbuck, A. F., & Paykel, E. S. (1995). Effects of major depression on the cognitive function of younger and older subjects. *Psychol Med*, 25(2), 285-295.
- Teasdale, J. D. (1983). Negative thinking in depression: cause, effect or reciprocal relationship. *Advances in Behaviour Research and Therapy*, 5, 3-25.

- Teasdale, J. D., & Barnard, P. J. (1993). *Affect, Cognition and Change: Remodelling depressive thought*. Hove: Lawrence Erlbaum Associates.
- Thompson, P. J. (1991). Antidepressants and memory: a review. *Human Psychopharmacology*, 6, 79-90.
- Trichard, C., Martinot, J. L., Alagille, M., Masure, M. C., Hardy, P., Ginestet, D., et al. (1995). Time course of prefrontal lobe dysfunction in severely depressed in-patients: a longitudinal neuropsychological study. *Psychol Med*, 25(1), 79-85.
- Tsourtos, G., Thompson, J. C., & Stough, C. (2002). Evidence of an early information processing speed deficit in unipolar major depression. *Psychol Med*, 32(2), 259-265.
- van Veen, V., & Carter, C. S. (2002). The anterior cingulate as a conflict monitor: fMRI and ERP studies. *Physiol Behav*, 77(4-5), 477-482.
- Vasko, T., & Kullberg, G. (1979). Results of psychological testing of cognitive functions in patients undergoing stereotactic psychiatric surgery. In E. R. Hitchcock, H. T. Ballantine & B. A. Meyerson (Eds.), *Modern concepts in psychiatric surgery* (pp. 303-310). New York: Elsevier/ North Holland Biomedical Press.
- Watkins, E., & Brown, R. G. (2002). Rumination and executive function in depression: an experimental study. *J Neurol Neurosurg Psychiatry*, 72(3), 400-402.
- Watkins, E., & Teasdale, J. D. (2001). Rumination and overgeneral memory in depression: effects of self-focus and analytic thinking. *J Abnorm Psychol*, 110(2), 353-357.

- Watkins, E., Teasdale, J. D., & Williams, R. M. (2000). Decentring and distraction reduce overgeneral autobiographical memory in depression. *Psychol Med*, 30(4), 911-920.
- Watkins, P. C. (2002). Implicit memory bias in depression. *Cognition and Emotion*, 16(3), 381 - 402.
- Watkins, P. C., Mathews, A., Williamson, D. A., & Fuller, R. D. (1992). Mood-congruent memory in depression: Emotional priming or elaboration? *Journal of Abnormal Psychology*, 101(3), 581-586.
- Watkins, P. C., Vache, K., Verney, S. P., Muller, S., & Mathews, A. (1996). Unconscious mood-congruent memory bias in depression. *Journal of Abnormal Psychology*, 105(1), 34-41.
- Wechsler, D. (1981). Wechsler adult intelligence scale-Revised. New York: Psychological Corporation.
- Weingartener, H., & Silberman, E. (1982). Models of cognitive impairment: Cognitive changes in depression. *Psychopharmacol Bull*, 18, 27-42.
- Wells, A., & Matthews, G. (1994). *Attention and emotion: A clinical perspective*. Hove, UK: Psychology Press, Taylor and Francis Group.
- Wild, B., Erb, M., & Martels, M. (2001). Are emotions contagious? Evoked emotions while viewing emotionally expressive faces: quality, quantity, time course and gender differences. *Psychiatry Research*, 102(2), 109-124.
- Wilhelm, S., McNally, R. J., Baer, L., & Florin, I. (1997). Autobiographical memory in obsessive-compulsive disorder. *Br J Clin Psychol*, 36(Pt 1), 21-31.
- Williams, J. M., & Broadbent, K. (1986). Autobiographical memory in suicide attempters. *J Abnorm Psychol*, 95(2), 144-149.

- Williams, J. M., Mathews, A., & MacLeod, C. (1996). The emotional Stroop task and psychopathology. *Psychol Bull*, 120(1), 3-24.
- Williams, J. M., & Scott, J. (1988). Autobiographical memory in depression. *Psychol Med*, 18(3), 689-695.
- Williams, J. M. G. (1996). The specificity of autobiographical memory in depression. In D. Rubin (Ed.), *Remembering our past: studies in autobiographical memory* (pp. 271-296). Cambridge: Cambridge University Press.
- Williams, J. M. G., & Dritschel, B. (1988). Emotional disturbance and the specificity of autobiographical memory. *Cognition and Emotion*, 2(3), 221-234.
- Williams, J. M. G., & Dritschel, B. H. (1992). Categorical and extended autobiographical memories. In M. A. Conway, D. C. Rubin, H. Spinnler & W. A. Wagenaar (Eds.), *Theoretical perspectives on autobiographical memory*. Dordrecht, Boston and London: Kluwer Academic Publishers.
- Williams, J. M. G., Healy, H., & Ellis, N. C. (1999). The effect of imageability and predictability of cues in autobiographical memory. *The Quarterly Journal of Experimental Psychology*, 52A(3), 555-579.
- Williams, J. M. G., & Nulty, D. D. (1986). Construct accessibility, depression and the emotional Stroop: transient emotion or stable structure? *Personality and Individual Differences*, 7, 485 - 491.
- Williams, J. M. G., Teasdale, J. D., Segal, Z. V., & Soulsby, J. (2000). Mindfulness-based cognitive therapy reduces overgeneral autobiographical memory in formerly depressed patients. *Journal of Abnormal Psychology*, 109(1), 150-155.
- Williams, J. M. G., Watts, F. N., MacLeod, C., & Mathews, A. (1997). *Cognitive psychology and emotional disorders* (second ed.). Chichester: Wiley.

- Winthorpe, C., & Rabbitt, P. A. (1988). Working memory capacity, IQ, age, and the ability to recount autobiographical events. In M. M. Gruneberg, P. E. Morris & R. N. Sykes (Eds.), *Practical aspects of memory: current research issues II* (pp. 175-179). Chichester: John Wiley.
- Zigmond, A. S., & Snaith, R. P. (1983). The hospital anxiety and depression scale. *Acta Psychiatr Scand*, 67(6), 361-370.

APPENDICES (CONTENTS)

APPENDIX	TITLE	PAGE
I	Screening questionnaire for control group	267
II	Power calculations	268
III	Characteristics of the words presented during the selective attention phase of the study reported in chapter 3	273
IV	Characteristics of the distracters presented during the recognition memory phase of the study reported in chapter 3	274
V	Analysis of the characteristics of the two sets of words utilised in the study reported in chapter 3	275
VI	Set A of Face/Word pairs presented during the selective attention phase	276
VII	Set B of Face/Word pairs presented during the selective attention phase	277
VIII	Practice and buffer stimuli presented during the selective attention phase	278
IX	Statistical control for co-morbid anxiety (chapter 3)	279
X	Words used to cue autobiographical memories during the study reported in chapter 4	281
XI	Positive and neural images used to cue ABMs during the study reported in chapter 4	282
XII	Negative images used to cue ABMs during the study reported in chapter 4	283
XIII	Faces used to cue ABMs during the study reported in chapter 4	284
XIV	Inter-rater reliability for coding of ABMs	285
XV	Statistical Control for co-morbid Anxiety (chapter 4)	286
XVI	Faces (Set A) presented to the participants during the encoding phase of the study reported in chapter 5	289
XVII	Faces (Set B) presented to the participants during the encoding phase of the study reported in chapter 5	290
XVII	Distracters (Set A) presented during the recognition memory phase of the study reported in chapter 5	291

XIX	Distracters (Set B) presented to the participants during the recognition memory phase of the study reported in chapter 5	292
XX	Statistical control for co-morbid anxiety (chapter 5)	293
XXI	Scoring guide for TASIT	294
XXII	Statistical control for co-morbid anxiety (chapter 6)	297

APPENDIX I

SCREENING QUESTIONNAIRE FOR CONTROL GROUP

PARTICIPANT CODE: _____ DATE: _____

DATE OF BIRTH _____ SEX M / F

YEARS OF FULL-TIME EDUCATION COMPLETED _____

I am now going to ask you a few questions to establish if you are suitable to take part in the current study. I have to warn you that some of the questions are of a personal nature. You do not have to answer them if you do not wish to.

Are you currently receiving treatment for depression? YES/NO

Have you ever suffered from depression? YES/NO

Have you ever received a head injury that resulted in loss
of consciousness? YES/NO

If yes, did you require hospital treatment? YES/NO

Are you currently on any medication? YES/NO

If yes, what medication _____

Are you currently being treated for drug or alcohol
problems? YES/NO

Are you currently being treated for any medical conditions? YES/NO

If yes, what medical condition _____

SUITABLE FOR STUDY: YES/ NO

APPENDIX II

Power calculations

$$d = (\xi - \mu) / \sigma$$

$$\alpha = 0.05$$

d = effect size

ξ = sample mean

μ = population mean

σ = population standard deviation

Chapter 3: Selective attention

Gotlib & Cane (1987)

Depressed: negative v neutral words $(860 - 803) / 180 = 0.3$

Depressed: negative v positive words $(860 - 819) / 184.5 = 0.2$

Positive words: depressed v controls $(860 - 750) / 102 = 0.98$

Neutral words: depressed v controls $(819 - 750) / 113 = 0.6$

Negative words: depressed v controls $(803 - 735) / 102 = 0.7$

$(0.3 + 0.2 + 1.0 + 0.6 + 0.7) / 5 = 0.6$ medium effect size

Stenberg, Wicking & Dahl (1998)

Negative v positive words; $726.7 - 686 / 54 = 0.8$

Positive words; Happy v neutral faces; $676 - 706 / 50 = 0.6$

Happy v sad faces; $676 - 717 / 50 = 0.8$

Negative words: Happy v sad; $730 - 694 / 58 = 0.6$

Neutral v sad; $729 - 694 / 58 = 0.6$

Happy faces: Positive v negative; $676 - 730 / 54 = 1$

Neutral faces: Positive v negative; $706 - 729 / 54 = 0.4$

Sad faces: Positive v negative; $717 - 694 / 54 = 0.4$

$(0.8 + 0.6 + 0.8 + 0.6 + 0.6 + 1.0 + 0.4 + 0.4) / 8 = 0.65$ (medium to large effect size)

According to Cohen (1992) the number of participants required to detect a large effect size using a 3 x 3 repeated measures ANOVA design is 13. However, as we have a between subjects factor we need to double this number 26 participants (13 depressed, 13 controls). The two effect sizes reported are 0.6 and 0.65, as we should aim to be conservative we should predict a medium effect size and aim for the larger sample size of 64 participants (32 depressed patients, 32 controls).

Chapter 4: ABM study

Williams & Scott (1988)

RT

Positive ABMs: depressed v controls $(21-14)/6.4 = 1.1$

Negative ABMs: depressed v controls $(14 - 17.5)/5.6 = 0.6$

Depressed: positive v negative $(21 - 14)/7 = 1$

Controls: positive v negative $(17.5 - 14)/5.6 = 0.6$

Mean $d = (1.0 + 0.7 + 1.1 + 0.6)/4 = 0.85$ (large effect size)

% Specific ABMs

Positive ABMs: depressed v controls $(0.7-0.3)/0.22 = 2.0$

Negative ABMs: depressed v controls $(0.6 - 0.5)/0.22 = 0.5$

Depressed patients: positive v negative $(0.3 - 0.5)/0.3 = 0.7$

Controls: positive v negative $(0.7 - 0.6)/0.13 = 0.8$

Mean $d = (0.8 + 0.7 + 0.5 + 2.0)/4 = 1.0$ (very large effect size)

Kuyken & Dalglish (1995)

Overgeneral ABMs

Positive ABMs: depressed v controls $(2.1 - 1.2)/1.25 = 0.7$

Negative ABMs: depressed v controls $(2.1 - 1.4)/1.1 = 0.6$

Mean $d = (0.7 + 0.6)/2 = 0.7$ (medium to large effect size)

Williams, Healy & Ellis (1999)

RT

Low image words v high image words $(11.2 - 6.9)/1.7 = 2.5$ (v large effect size)

% Specific ABMs

Low image words v high image words $(2.0 - 2.4)/0.2 = 2.0$ (v large effect size)

Mean $d = (2.0 + 2.5)/2 = 2.25$ (v large effect size)

The reported effect sizes vary from 0.7 (medium to large) to 2.25 (very large)

According to Cohen (1992) the number of participants required to detect a medium effect size (at 0.8 power) using a 2 x 3 repeated measures ANOVA is 35. However, as we have a between subjects factor this number should be doubled to 70 participants (35 patients 35 controls). The number of participants required to detect a large effect using a 2 x 3 repeated measures ANOVA is 14. However, as there is a between subjects factor this should be doubled to 28 (14 depressed patients, 14 controls). Also cited in Cohen (1992) is the number of participants required to detect a (large) difference between 2 means is 26 in each group.

Chapter 5: Face memory study

Ridout et al (2003)

Depressed patients: Sad v happy faces $(87.5 - 73.8)/16.4 = 0.84$

Sad v neutral faces $(87.5 - 75.6)/12.7 = 0.94$

Controls: Happy v sad $(88.7 - 78.1)/12.4 = 0.85$

Happy v neutral $(88.7 - 78.4)/11.1 = 0.93$

Happy faces: controls v depressed $(88.7 - 73.8)/14.8 = 1.0$

Sad faces: depressed v controls $(87.5 - 78.1)/14 = 0.67$

Mean $d = (0.84 + 0.94 + 0.85 + 0.93 + 1.0 + 0.67)/6 = 0.87$ (large effect size)

According to Cohen (1992) the number of participants required to detect a large effect size (at 0.8 power) using one-way repeated measures ANOVA is 21. However, as we have a between subjects variable this number should be doubled to 42 (21 patients & 21 controls).

Chapter 6: Emotion recognition & Social processing study

Emotion recognition

Persad & Polivy (1993)

Controls v depressed $(0.96 - 0.85)/0.1 = 1.1$

McDonald et al (2003)

Controls v brain injured $(25.9 - 19.8)/3 = 2$

Mean $d = (1.1 + 2)/2 = 1.6$ (very large effect size)

Social perception

McDonald et al (2003)

Sincere: BI v controls $(18.3 - 16.1)/2.5 = 0.8$

Sarcastic: controls v BI $(38.6 - 30.8)/5.6 = 1.4$

Lies: controls v BI $(27.7 - 25.5)/4 = 0.6$

Sarcastic (II): controls v BI $(28.1 - 21.1)/5 = 1.4$

Mean $d = (0.8 + 1.4 + 0.6 + 1.4)/4 = 1.1$ (very large effect size)

According to Cohen (1992) the number of participants required to detect a large effect (with a power of 0.8) using a 2 x 2 repeated measures ANOVA is 18. However, as we have a between subject factor this number must be doubled to 36 (18 depressed patients, 18 controls).

Chapter 7: Neurosurgery, emotion recognition and social perception

McDonald et al (2003)

As noted above McDonald et al (2003) reported very large differences between the brain injured patients and healthy controls (Mean $d=1.1$).

According to Cohen (1992) the number of participants required to detect large effects is 18 as we have three groups this number should be trebled to 54 (18 surgery patients, 18 depressed patients and 18 controls). Also as we hope to make comparisons between recovered and still depressed surgery patients the number should really be quadrupled to 72 (18 recovered, 18 still depressed surgery patients, 18 depressed patients and 18 controls)

APPENDIX III

Characteristics of the words presented during the selective attention phase of the study reported in chapter 3

Word	% agreement	Emotionality	Length	Frequency	Valence
LOVABLE	100	5.59	8	2	positive
PLEASANT	100	4.29	8	35	positive
CARING	100	5.29	6	10	positive
CHEERFUL	100	5.08	8	10	positive
CONFIDENT	100	4.93	9	17	positive
CONSIDERATE	99	4.63	11	4	positive
TRUSTWORTHY	99	4.89	11	3	positive
CREATIVE	99	4.6	8	49	positive
EXHILARATED	98	5.68	11	1	positive
ELATED	93	5.34	6	3	positive
ENCHANTING	97	4.82	10	9	positive
AMUSING	96	4.59	7	14	positive
Mean	98.4	5.0	8.6	13.1	
SD	2.2	0.4	1.8	14.7	
RESIDENT	100	1.85	8	28	neutral
SIDEBORD	100	1.57	9	2	neutral
EQUIVALENT	98	1.99	10	36	neutral
PACKAGE	98	1.65	7	14	neutral
MEDIUM	98	1.61	6	9	neutral
INITIAL	97	1.68	7	69	neutral
LODGE	97	1.36	5	17	neutral
LIBRARY	96	1.68	7	20	neutral
BUNCH	96	1.61	5	18	neutral
FURNISHING	96	1.57	10	12	neutral
GENE	95	2.13	4	11	neutral
GRAPHITE	95	1.72	8	5	neutral
Mean	97.2	1.7	7.2	20.1	
SD	1.7	0.2	1.9	18.1	
ASHAMED	100	5.37	7	17	negative
HOPELESS	100	5.58	8	14	negative
HURT	100	5.46	4	1	negative
UNHAPPY	100	5.58	7	26	negative
UNPOPULAR	100	5.3	9	6	negative
HUMILIATED	100	5.86	11	2	negative
HELPLESS	99	5.17	8	21	negative
GLOOMY	99	4.9	6	3	negative
MISERABLE	99	5.83	9	13	negative
INCOMPETENT	98	4.79	11	2	negative
SULKING	98	4.72	7	1	negative
ISOLATED	98	5.17	8	35	negative
Mean	99.3	5.3	7.9	11.8	
SD	0.9	0.4	2.0	11.3	

APPENDIX IV
**Characteristics of the distracters presented during the recognition
memory phase of the study reported in chapter 3**

Word	% agreement	Emotionality	Length	Frequency	Valence
ENTHUSIASTIC	100	5.26	12	24	positive
LOVING	100	6.1	6	14	positive
MERRY	100	4.89	5	8	positive
UNSELFISH	100	4.75	9	1	positive
FRIENDLY	99	5.04	8	61	positive
JOLLY	99	5.15	5	4	positive
EUPHORIC	99	6.09	8	4	positive
EXCITED	99	5.44	7	21	positive
CHARMING	98	4.53	8	24	positive
GENEROUS	98	5.1	10	9	positive
ENTERTAINING	97	4.41	12	4	positive
JUBILANT	95	5.44	8	4	positive
Mean	98.7	5.2	8.2	14.8	
SD	1.5	0.5	2.3	16.7	
CLOCK	100	1.48	5	28	neutral
LOCKER	99	1.35	6	19	neutral
CIVILIAN	98	2.06	8	10	neutral
PENDULUM	98	1.68	8	2	neutral
SERVETTE	97	1.76	9	1	neutral
DEPUTY	97	1.83	6	5	neutral
CATALOGUE	97	1.63	9	16	neutral
REPRINT	96	1.78	6	3	neutral
RAINCOAT	96	1.47	8	2	neutral
RECIPE	96	1.49	6	9	neutral
INTERNAL	95	2.32	8	62	neutral
PEDESTRIAN	94	1.88	10	3	neutral
Mean	97.0	1.7	7.4	13.3	
SD	1.7	0.3	1.6	17.4	
SUFFERING	100	6.03	9	30	negative
WORTHLESS	100	5.56	9	3	negative
LONELY	100	5.75	6	25	negative
DEPRESSED	100	6.06	9	10	negative
SAD	100	5.58	3	35	negative
USELESS	99	5.24	7	17	negative
INFERIOR	99	4.93	8	8	negative
UNWANTED	99	5.51	8	6	negative
DISLIKED	98	5.2	8	11	negative
DREARY	98	4.38	6	6	negative
INADEQUATE	98	5.26	10	32	negative
BORING	97	4.42	6	4	negative
Mean	99.0	5.3	7.4	15.6	
SD	1.0	0.5	1.9	11.8	

APPENDIX V

Analysis of the characteristics of the two sets of words utilised in the study reported in chapter 3

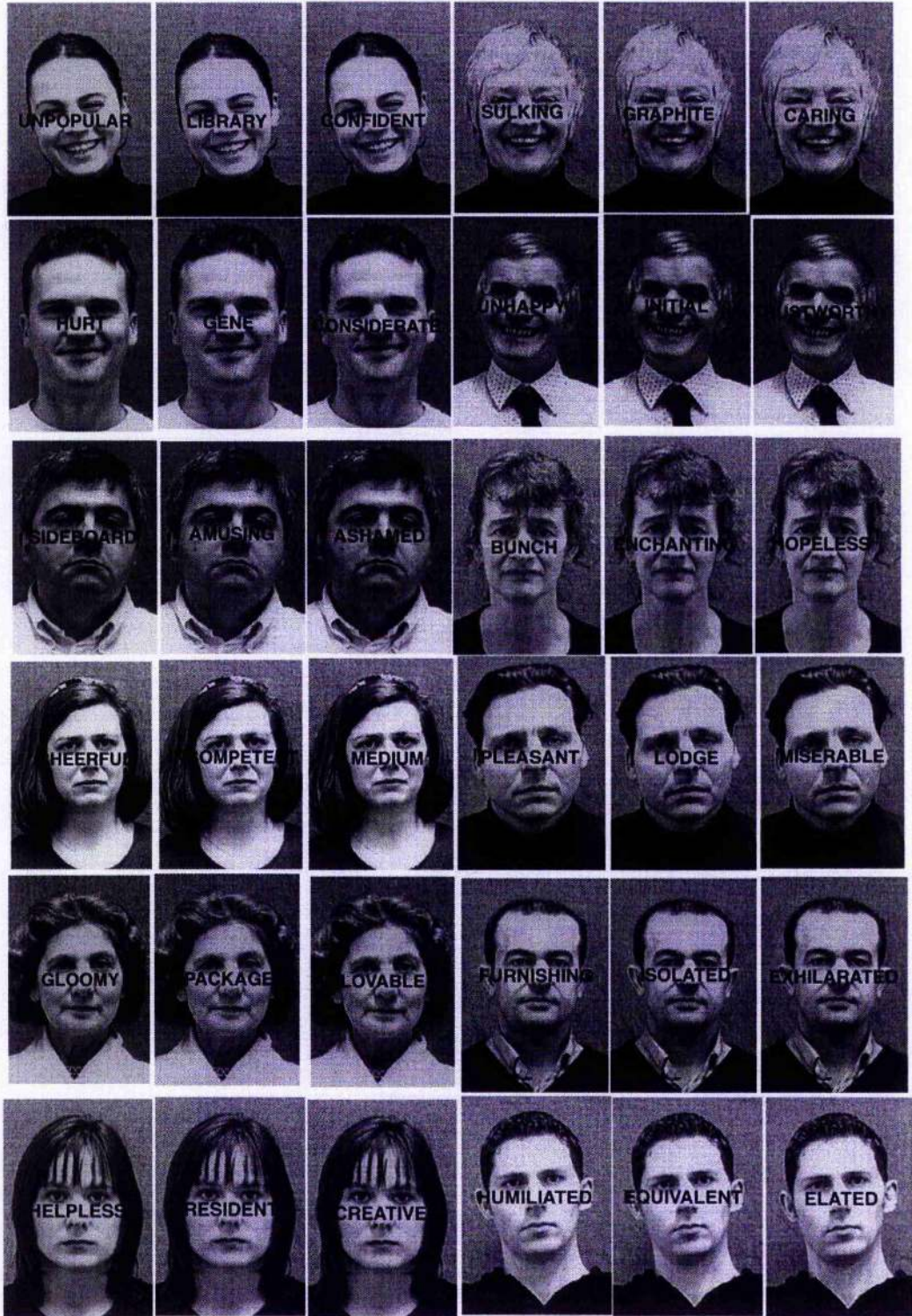
The characteristics of the two sets of words were analysed using a MANOVA with percentage subjective agreement, emotionality ratings, word length and word frequency as the dependent variables and word valence (positive, neutral & negative) and word set (target words & distracters) as the independent variables. This analysis revealed a significant effect of word valence in terms of percentage agreement; $F(2, 66)=11.6, P<0.001$. Further analysis revealed that overall there was significantly lower subjective agreement concerning the valence of the categorised neutral words ($\mu=97.0\%$, $SD=1.7$) than for either the positive ($\mu=98.5\%$, $SD=1.5$) or negative words ($\mu=99.1$, $SD=1.0$); both tests $p<0.001$. There was no significant difference between positive and negative words in terms of percentage subjective agreement. The main analysis also revealed a significant effect of word valence on the emotionality ratings, $F(2, 66)=569.9, p<0.0001$. As expected neutral words were rated as significantly less emotional ($\mu=1.7$, $SD=0.3$) than were the positive ($\mu=5.1$, $SD=0.5$) or negative words ($\mu=5.3$, $SD=1.5$); both tests $p<0.0001$. There was no significant difference between the positive and negative words in terms of their perceived emotional strength (emotionality). The main analysis also revealed that there was no significant differences overall between the two sets of words and no significant valence x word set interaction, both tests $F<1$.

Conclusion

Although there was a significant difference between the neutral and emotional words in terms of percentage of subjective agreement it would seem unlikely that this difference (1.5 – 2%) would exert an marked influence on the participants' performance of the tasks included in chapter 3. Importantly the characteristics of the two word lists did not differ significantly.

APPENDIX VI

Set A of Face/Word pairs presented during the selective attention phase



APPENDIX VII

Set B of Face/Word pairs presented during the selective attention phase



APPENDIX VIII

Practice and buffer stimuli presented during the selective attention phase

Practice Stimuli



Buffer Stimuli



APPENDIX IX

Statistical control for co-morbid anxiety (chapter 3)

Valence identification (VI) times

Difference in VI times for words paired with happy and neutral faces

Correlational analysis revealed that both BDI and HADS_D were significantly negatively correlated with the difference in participants' valence identification times for words paired with happy and neutral faces; $r(64)=-0.25$, $p<0.05$ and $r(64)=-0.28$, $p<0.05$ respectively. A stepwise regression was conducted in order to establish if the difference in valence identification times could be predicted from the participants' scores on these mood measures. This analysis provided a significant model that accounted for around 10% of the variance, $R^2=0.08$, adjusted $R^2=0.06$; $F(1, 62)=5.2$, $p<0.05$. HAD_D score emerged as the strongest predictor; Beta -0.28 , $p<0.05$.

Difference in VI times for words paired with happy and sad faces

Correlational analysis revealed that both HADS_D and HADS_A were significantly negatively correlated with the difference in participants' valence identification times for words paired with happy and sad faces; $r(64)=-0.30$, $p<0.05$ and $r(64)=-0.29$, $p<0.05$ respectively. A stepwise regression was conducted in order to establish if the difference in valence identification times could be predicted from the participants' scores on these mood measures. This analysis provided a significant model that accounted for around 10% of the variance, $R^2=0.09$, adjusted $R^2=0.07$; $F(1, 62)=5.9$, $p<0.05$. HADS_D score emerged as the strongest predictor; Beta -0.30 , $p<0.05$.

Differences in VI times for congruent and incongruent faces/word pairs

Correlational analysis revealed a moderate relationship between participants' BDI score and the difference in VI times for congruent and incongruent face/word pairs; $r(64)=0.19$, $p=0.06$. HADS anxiety and depression scores were not significantly correlated with the difference in VI times, $p>0.05$.

Percentage of positive words correctly recognised during memory testing

Correlational analysis revealed that both BDI and HADS_D scores were significantly negatively correlated with the percentage of positive words correctly recognised by the participants during the memory phase; $r(64)=-0.30$, $p<0.05$ and $r(64)=-0.37$, $p<0.01$ respectively. A stepwise regression was conducted in order to establish if the percentage of positive words correctly recognised during the memory phase could be predicted from the participants' scores on these mood measures. This analysis provided a significant model that accounted for around 13% of the variance, $R^2=0.13$, adjusted $R^2=0.12$; $F(1, 62)=9.6$, $p<0.01$. HADS_D score emerged as the strongest predictor; Beta -0.37 , $p<0.01$.

Conclusion

The results of these analyses suggest that it is depression, and not anxiety, that contributes most strongly to the explanation of the differences in attention and memory performance identified in chapter 3.

Appendix X

Words used to cue autobiographical memories during the study reported in chapter 4

PRACTICE CUE WORDS	POSITIVE CUE WORDS	NEGATIVE CUE WORDS
BUS TABLE	HAPPY INTERESTED SAFE SUCCESSFUL SURPRISED	LONELY CLUMSY SORRY ANGRY HURT (EMOTIONALLY)

APPENDIX XI
Positive and neutral images used to cue ABMs during the study
reported in chapter 4

Practice Images

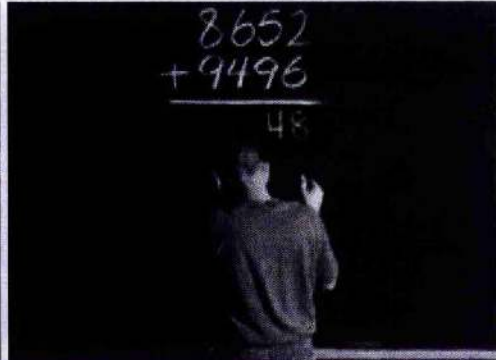


Positive Images



APPENDIX XII
Negative images used to cue ABMs during the study reported in
chapter 4

Negative Images



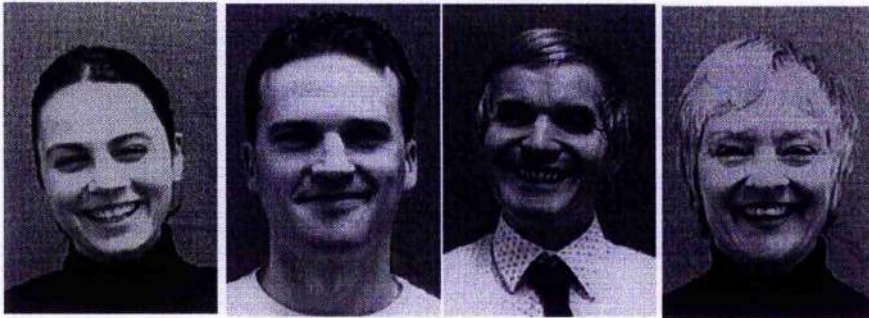
APPENDIX XIII

Faces used to cue ABMs during the study reported in chapter 4

Practice Faces



Positive Faces



Negative Faces



APPENDIX XIV

Inter-rater reliability for coding of ABMs

Correlational analysis revealed that there were significant correlations between the number of memories that were coded by the principle researcher (NR) and the independent 'blind' rater (BD) as specific; $r(20)=0.97$, $P<0.001$, extended; $r(20)=0.6$, $P<0.01$ or categorical; $r(20)=0.98$, $P<0.001$. These findings demonstrate a mean inter-rater agreement of 85%.

Mean number of memories coded by the two raters as specific, extended or categorical (standard errors are presented in parentheses)

Type of ABM	Rater: NR	Rater: BD
Specific	5.9 (0.7)	5.7 (0.7)
Extended	0.5 (0.2)	0.7 (0.2)
Categorical	3.2 (0.7)	3.1 (0.7)

Analysis of the data presented in the table revealed that the two raters did not differ significantly in terms of the number of memories they coded as specific; $t(38)=0.2$, $P>0.05$, extended; $t(38)=1.0$, $P>0.05$ or categorical; $t(38)=0.1$, $P>0.05$.

These analyses demonstrate a high level of inter-rater agreement in terms of coding the different types of memories.

APPENDIX XV

Statistical Control for Co-morbid Anxiety (chapter 4)

ABM Retrieval Times

Positive ABMs

Correlational analysis revealed that both BDI and HADS_A were significantly correlated with positive ABM retrieval time; $r(50)=0.4$, $p<0.01$ and $r(50)=0.3$, $p<0.05$ respectively. A stepwise regression was conducted in order to establish if the retrieval times of positive ABMs could be predicted from depression (BDI) and anxiety (HADS_A) scores. This analysis provided a significant model that predicted 16% of the variance, $R^2=0.16$, adjusted $R^2=0.15$; $F(1, 48)=9.3$, $p<0.01$. BDI score emerged as the strongest predictor; Beta 0.4, $p<0.01$.

Number of ABMs retrieved

Positive

Correlational analysis revealed that BDI was significantly negatively correlated with the number of positive ABMs retrieved by the participants, $r(50)=-0.3$, $p<0.05$. However, HADS_A was not significantly correlated with the number of positive ABMs, $p>0.05$. A stepwise regression was conducted in order to establish if the number of positive memories produced by the participants could be predicted from the depression (BDI) and anxiety (HADS_A) scores. The analysis produced a significant model that accounted for 9% of the variance; $R^2=0.09$, adjusted $R^2=0.07$; $F(1, 48)=4.6$, $p<0.05$. BDI score emerged as the strongest predictor; Beta -0.3, $p<0.05$.

Percentage of Specific ABMs

Words

Correlational analysis revealed that both BDI and HADS_A scores were significantly negatively correlated with the number of specific ABMs retrieved by the participants when cued with words, $r(50)=-0.41$, $p<0.01$ and $r(50)=-0.39$, $p<0.01$ respectively. A stepwise regression analysis was conducted to establish if the percentage of specific ABMs retrieved in response to word cues could be predicted from the participants' depression (BDI) and anxiety (HADS_A) scores. This analysis revealed a significant model that explained 17% of the variance; $R^2=0.17$, adjusted $R^2=0.15$, $F(1, 48)=9.6$, $p<0.01$. Furthermore, BDI score emerged as the strongest predictor; $Beta=-0.41$, $p<0.01$.

Images

Correlational analysis revealed that both BDI and HADS_A scores were significantly negatively correlated with the number of specific ABMs retrieved by the participants when cued with images, $r(50)=-0.61$, $p<0.001$ and $r(50)=-0.56$, $p<0.001$ respectively. A stepwise regression analysis was conducted to establish if the percentage of specific ABMs retrieved in response to image cues could be predicted from the participants' depression (BDI) and anxiety (HADS_A) scores. This analysis revealed a significant model that explained 37% of the variance; $R^2=0.37$, adjusted $R^2=0.36$, $F(1, 48)=28.0$, $p<0.001$. Furthermore, BDI score emerged as the strongest predictor; $Beta=-0.61$, $p<0.001$.

Faces

Correlational analysis revealed that both BDI and HADS_A scores were significantly negatively correlated with the number of specific ABMs retrieved by the participants

when cued with faces, $r(50)=-0.57$, $p<0.001$ and $r(50)=-0.52$, $p<0.001$ respectively. A stepwise regression analysis was conducted to establish if the percentage of specific ABMs retrieved in response to face cues could be predicted from the participants' depression (BDI) and anxiety (HADS_A) scores. This analysis revealed a significant model that explained 33% of the variance; $R^2=0.33$, adjusted $R^2=0.31$, $F(1, 48)=23.1$, $p<0.001$. Furthermore, BDI score emerged as the strongest predictor; $Beta=-0.57$, $p<0.001$.

Number of Categorical ABMs

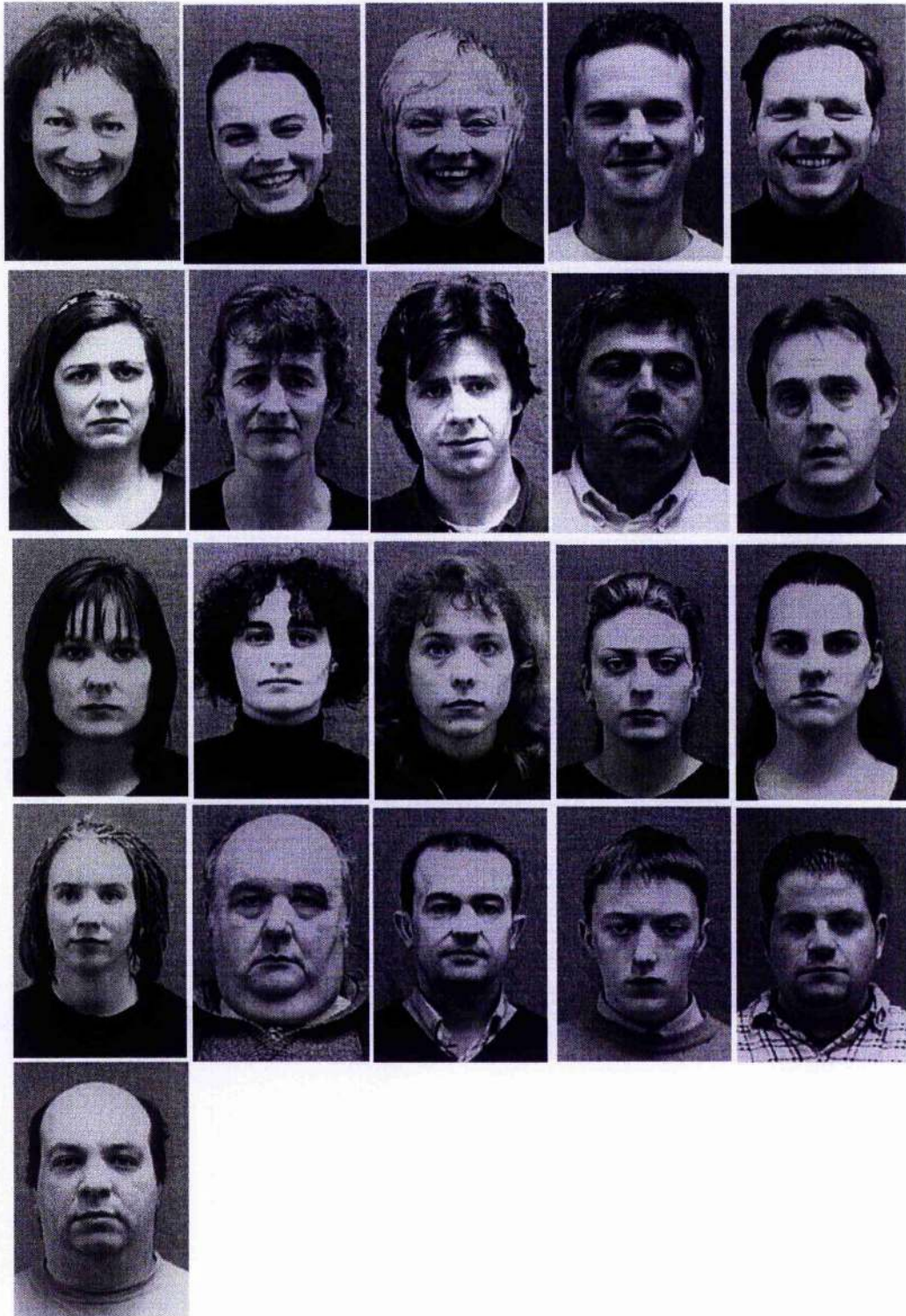
Correlational analysis revealed that both BDI and HADS_A scores were significantly associated with the number of categorical retrieval errors produced by the participants; $r(50)=0.57$, $p<0.001$ and $r(50)=0.56$, $p<0.001$ respectively. A stepwise regression was conducted in order to establish if the number of categorical memories retrieved by the participants could be predicted from depression (BDI) and anxiety (HADS_A) scores. This analysis revealed a significant model that explained 33% of the variance; $R^2=0.33$, adjusted $R^2=0.32$; $F(1, 48)=24.5$, $P<0.001$. Furthermore, BDI emerged as the strongest predictor; $Beta=0.57$, $p<0.001$.

Conclusion

The results of all of these analyses suggest that it is depression, and not anxiety, that consistently contributes most strongly to the explanation of the differences in ABM retrieval reported through out this chapter.

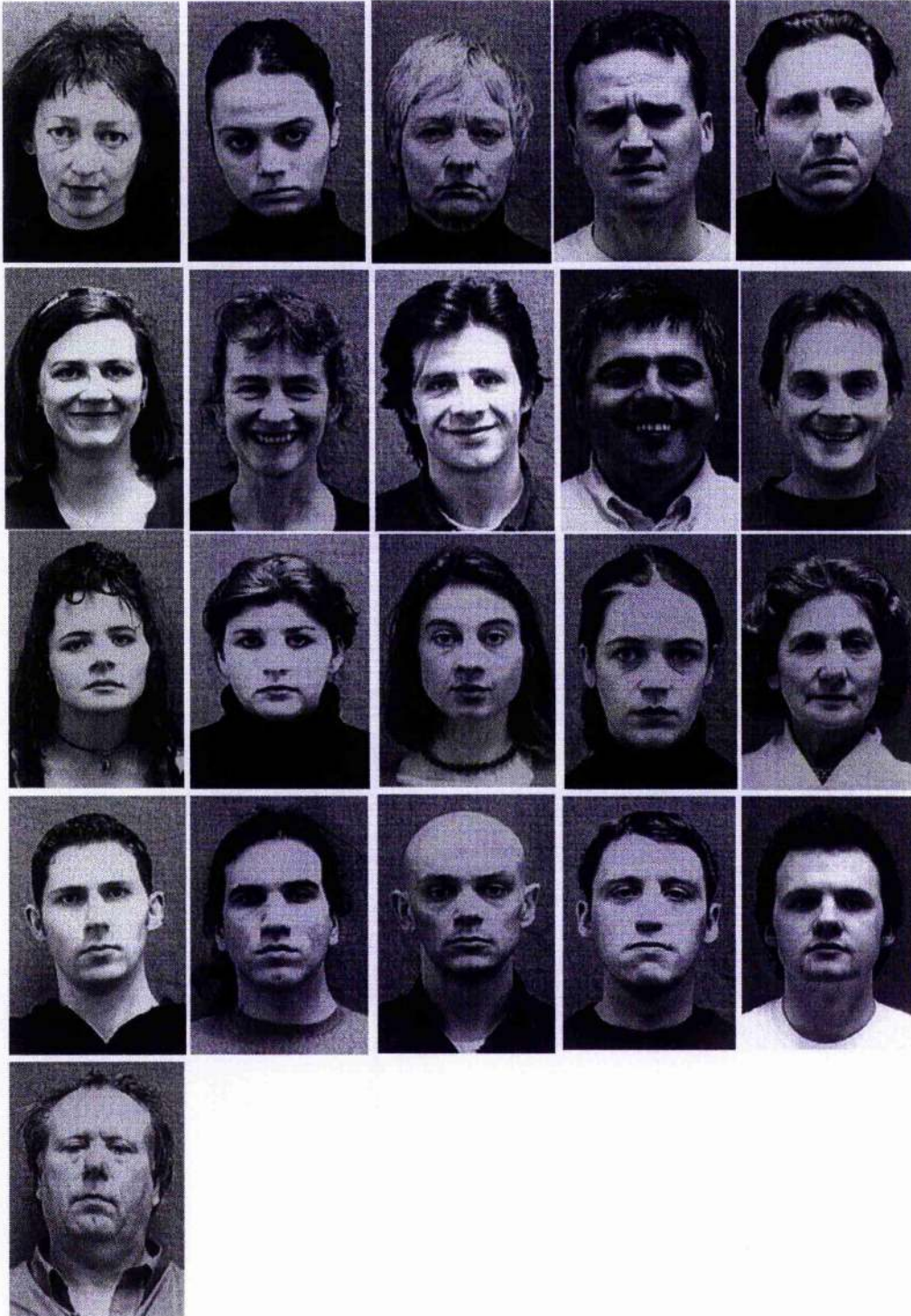
APPENDIX XVI

Faces (Set A) presented to the participants during the encoding phase of the study reported in chapter 5



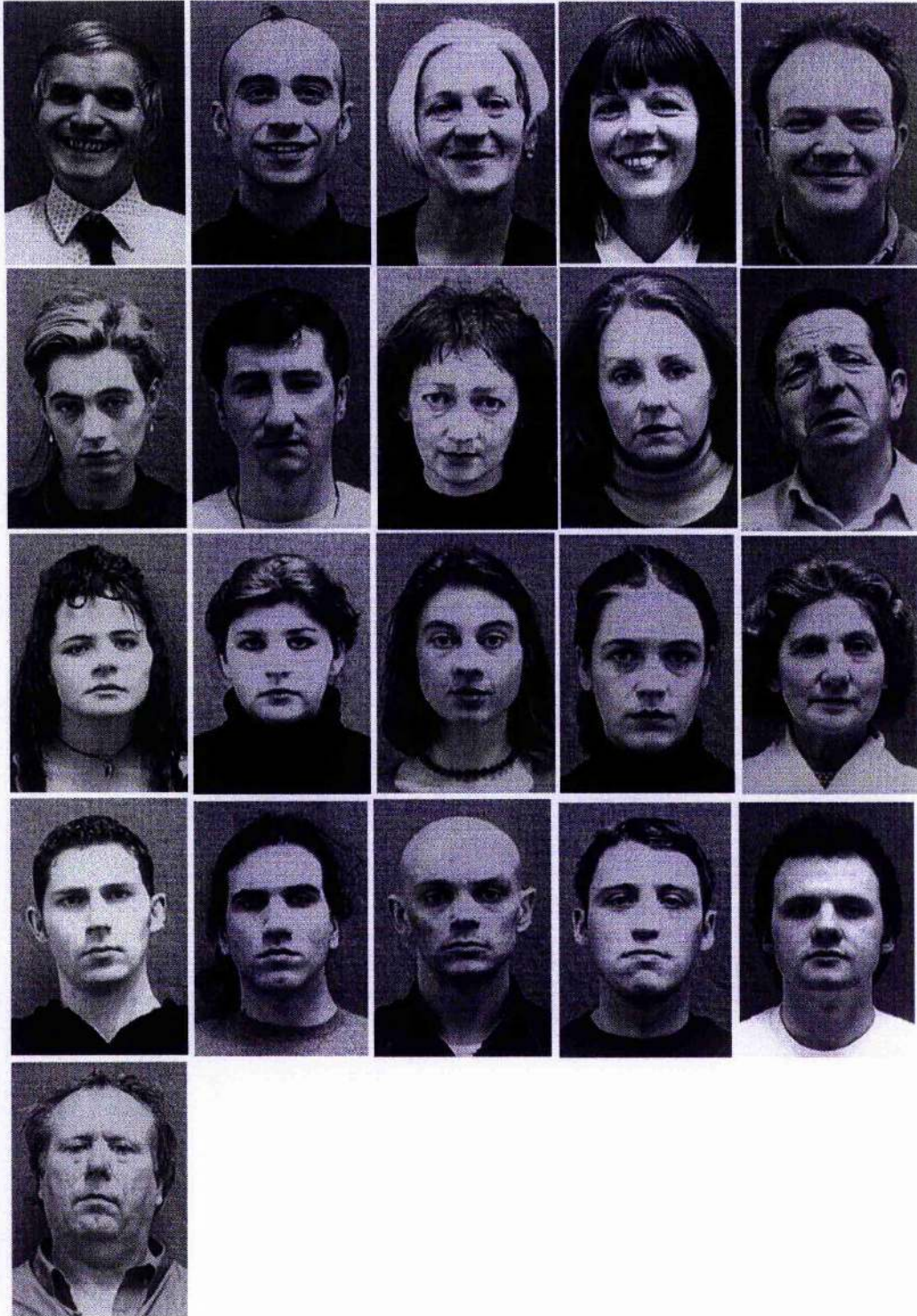
APPENDIX XVII

Faces (Set B) presented to the participants during the encoding phase
of the study reported in chapter 5



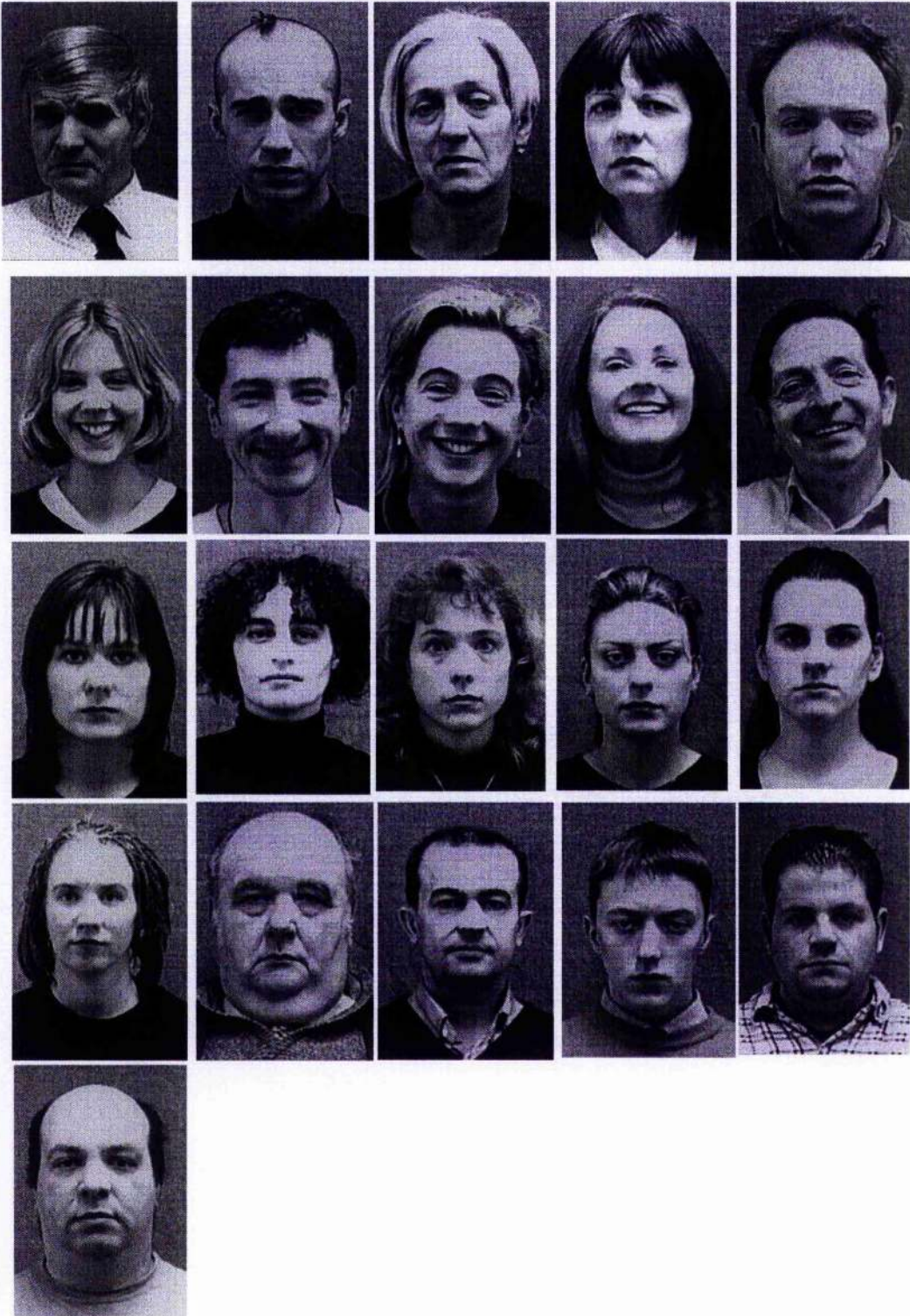
APPENDIX XVIII

Distracters (Set A) presented during the recognition memory phase of the study reported in chapter 5



APPENDIX XIX

Distracters (Set B) presented to the participants during the recognition memory phase of the study reported in chapter 5



APPENDIX XX

Statistical control for co-morbid anxiety (chapter 5)

Percentage of correctly recognised sad faces

Correlational analysis revealed that BDI, HADS_D and HADS_A were all significantly correlated with the percentage of sad faces correctly recognised during the memory phase of this study; $r(34)=-0.58$, $p<0.001$; $r(34)=-0.62$, $p<0.001$ and $r(34)=0.56$, $p<0.01$ respectively. A stepwise regression was conducted in order to establish if the percentage of sad faces correctly recognised during the memory phase could be predicted from depression (BDI & HADS_D) and anxiety (HADS_A) scores. This analysis provided a significant model that accounted for around 40% of the variance, $R^2=0.39$, adjusted $R^2=0.37$; $F(1, 32)=20.3$, $P<0.001$. HADS_D score emerged as the strongest predictor; Beta -0.62 , $P<0.001$. These findings suggest that the observed differences in percentage of sad faces correctly recognised during the memory phase are more strongly related to differences in depression, rather than anxiety.

APPENDIX XXI

SCORING GUIDE FOR TASIT

Emotion Evaluation Phase

The Emotion Evaluation phase of TASIT consists of 28 video clips (four clips featuring each of the seven basic emotions; happiness, sadness, anxiety, anger, surprise, disgust & neutral expression). The participants' responses are compared to expected emotion label for each clip (indicated on the TASIT score sheet). Therefore, for each emotion there is a maximum score of four. The authors of TASIT grouped happiness, surprise and neutral expressions together under the umbrella term of positive emotion. Sadness, anxiety, anger & disgust were grouped together as negative emotion. Therefore, the maximum scores for positive and negative emotions are 12 and 16 respectively. In order to investigate relative differences in the recognition of the different classes of expressions (positive & negative valence) the maximum scores were translated into percentage correct recognitions.

Social Inference Minimal (SIM)

The SIM phase involves presenting fifteen videotaped social interactions. In five of the clips both protagonists are being sincere. However, in the other ten clips one of the characters is being sarcastic. Following each video clip the participants are asked four questions concerning the social interaction they have just viewed. The participants are only required to make a 'YES', 'NO' or 'DON'T KNOW' response (they are encouraged to give a yes or no response wherever possible). The participants' responses to each question are recorded on the TASIT score sheet and compared to the designated correct (or expected) response (indicated on the TASIT score sheet).

Examples of the type of questions are as follows:

A. Is Ruth trying to make Michael feel appreciated?

B. Is she trying to say he has been a big help?

C. Does she think he has worked hard?

D. Is she annoyed with him?

In the above example, in the sincere condition the correct responses would be A=YES, B=YES, C=YES and D=NO

However, in the sarcastic condition the correct responses would have been A=NO, B=NO, C=NO, D=YES

The participants receive one point for each of their responses that match the correct (expected) interpretation (indicated on the TASIT score sheet). Participants receive a score of zero for incorrect & don't know responses. Thus, the maximum scores for sincere and sarcastic interactions are 20 and 40 respectively. In order to allow comparison of relative differences in the accuracy of interpretation of the two types of interaction (sincere & sarcastic) the total scores of the participants were converted to percentage correct interpretations.

Social Inference Enriched (SIE)

The SIE phase of TASIT involves presenting participants with sixteen videotaped social interactions. In half of the interactions one of the protagonists is telling a 'white lie' to play down the truth, in the remaining interactions one of the protagonists is being sarcastic in order to make clear their feelings to the other person. As with SIM phase, following each clip the participants are asked four questions concerning the

meaning of the social interaction they have just viewed. The participants are again only asked to provide YES, NO or DON'T KNOW responses. The participants' responses to each question are recorded on the TASIT score sheet and are compared to the designated correct (or expected) response.

An example of the type of questions that are asked during the SIE phase are as follows:

When Ruth is talking to Gary in the changing room

- A. Is she trying to make him put on weight?*
- B. Is she trying to say that he has put on weight?*
- C. Does she think he has put on weight?*
- D. Does he seem happy with her?*

In the above example, in the 'white lie' condition the correct responses would be A=NO, B=NO, C=YES and D=YES

However, in the sarcastic condition the correct responses would have been A=YES, B=YES, C=YES, D=NO

As in the SIM phase, the participants receive one point for each of their responses that match the correct (expected) interpretation (indicated on the TASIT score sheet) and zero for incorrect & don't know responses. Thus, the maximum score for both the 'white lie' and sarcastic interactions is 32. In order to allow the performance of the participants on the SIM and SIE phases to be compared the total scores of the participants were converted to percentage correct interpretations.

APPENDIX XXII

Statistical control for co-morbid anxiety (chapter 6)

Emotion recognition phase

Positive and negative expressions

Correlational analysis revealed that there were no significant relationships between the participants' scores on the mood measures and the percentage of positive and negative emotional expressions correctly interpreted, all tests $p > 0.05$.

Happy expressions

Correlational analysis revealed that BDI and HADS_D scores were both significantly negatively correlated with the percentage of happy emotional expressions correctly interpreted during the emotion recognition phase; $r(28) = -0.34$, $p < 0.05$ (one-tailed); and $r(28) = -0.28$, $p < 0.05$ (one-tailed). However, participants' scores on the HADS anxiety scale were not significantly correlated with the percentage of happy expression correctly interpreted, $p > 0.05$.

Social Inference –minimal (SIM) phase

Sarcastic social interactions

Correlational analysis revealed that BDI, HADS_D and HADS_A scores were all significantly negatively correlated with the percentage of sarcastic social interactions that were correctly interpreted during the social inference (minimal) phase; $r(28) = -0.63$, $p < 0.001$; $r(28) = -0.57$, $p < 0.001$ and $r(28) = -0.42$, $p < 0.05$ respectively. A stepwise regression was conducted in order to establish if the percentage of sarcastic interactions correctly interpreted during the SIM phase could be predicted from the participants' scores on the mood measures. This analysis produced a significant model

that accounted for around 40% of the variance; $F(1, 26)=16.95$, $p<0.001$; $R^2=0.40$, adjusted $R^2=0.37$; $F(1, 48)=4.6$, $p<0.05$. BDI score emerged as the strongest predictor; Beta -0.63 , $p<0.001$.

Social inference-enriched (SIE) phase

Sarcastic interactions

Correlational analysis revealed that BDI and HADS_D scores were both significantly negatively correlated with the percentage of sarcastic social interactions that were correctly interpreted during the SIE phase; $r(28)=-0.56$, $p<0.01$ and $r(28)=-0.55$, $p<0.01$ respectively. A stepwise regression was conducted in order to establish if the percentage of sarcastic interactions correctly interpreted during the SIE phase could be predicted from the participants' scores on these mood measures. This analysis produced a significant model that accounted for around 30% of the variance; $F(1, 26)=11.57$, $p<0.01$; $R^2=0.31$, R^2 adjusted=0.28. BDI emerged as the strongest predictor Beta $=-0.56$, $p<0.01$.

Social interactions involving lies

Correlational analysis revealed that BDI, HADS_D and HADS_A scores were all significantly negatively correlated with the percentage of social interactions involving lies that were correctly interpreted by the participants during the SIE phase; $r(28)=-0.58$, $p<0.01$, $r(28)=-0.55$, $p<0.01$ and $r(28)=-0.38$, $p<0.05$ respectively. A stepwise regression was conducted in order to establish if the percentage of social interactions involving lies that were correctly interpreted by the participants during the SIE phase could be predicted from the participants' scores on the mood measures. This analysis produced a significant model that accounted for around 30% of the variance; $F(1,$

26)=13.0, $p<0.01$; $R^2=0.33$, R^2 adjusted=0.31. BDI emerged as the strongest predictor
Beta=-0.58, $p<0.01$.

Conclusion

The results of these analyses suggest that it is depression, and not anxiety, that consistently contributes most strongly to the explanation of the differences in emotion recognition and social perception outlined in chapter 6.